DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

Edited by Bernard Lintern

Volume XIII

JANUARY TO DECEMBER

1932

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WHAT IS A VIRUS?

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THE NEW ERA IN FARMING.

(See page 10)

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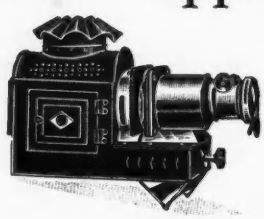

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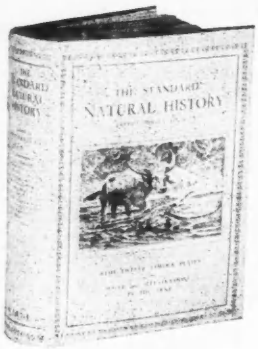

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Notes of the Month.

Preparations are now being made for an international Polar expedition which is to spend twelve months in the Arctic. It will commemorate the jubilee of the first Polar Year in 1882, and Great Britain will again play a leading part. The arrangements are not yet complete, but preliminary plans are outlined on another page by Professor Debenham. The British party will be stationed at Fort Rae in northern Canada, and will be entirely isolated, probably even without means of wireless communication. Fort Rae is farther north than the station occupied by the British expedition in 1882, and while inhabited by a colony of Indians in the summer, it is completely deserted in winter. The work will be largely meteorological and will include a study of the upper atmosphere by means of balloons, fitted with instruments for measuring the temperature and pressure. Special observations will be made of the stratosphere and the speed of currents. The balloons must reach a height of five or six miles before the necessary records can be obtained, and their recovery is likely to present the chief difficulty. When the work is concluded in August, 1933, the results will be examined by specialists in its various branches.

* * * * *

The new anti-aircraft searchlight tested in London last month attracted a good deal of attention. The beam throws a pattern on the sky in the form of a grid which consists of a number of squares. It is therefore far more difficult for an aeroplane to escape from the network of light than when a single beam is used. The new searchlight can locate a machine at a height of 16,000 feet, and is capable of recording its speed, height and direction. The strength of the light is 3,000,000,000 candle power and the beams are deflected by a series of mirrors. The light is enclosed in a huge drum which can rotate through a complete circle and is mounted on a lorry. Alternative patterns may be substituted for the grid device, producing circles or a flat beam instead of the squares. An expert states that six searchlights of the flat beam type are capable of illuminating the whole horizon and that a newspaper may be read by the light at a distance of five miles.

* * * * *

Important research for the fishing industry is being carried out with a new instrument for studying the plankton. This has been designed by Professor D. C. Hardy of the Department of Marine Biology at Hull University, and is now being used by several vessels in the North Sea. When the instrument is thrown overboard it collects the plankton in a sieve. The success of fishing depends, of course, to a large extent on a knowledge of plankton distribution, which determines the locality of fish. Valuable results are already reported for the herring industry and the scope of the work is to be extended by using a larger and more comprehensive instrument. The movement of the plankton is, of course, influenced by currents, and it is hoped to discover the extent of the movement. Records will be compiled from the catches made by North Sea vessels, in order to forecast the position of the types of plankton by which fish are either attracted or repelled. The advantage of this information to the fishing fleets will naturally be considerable.

* * * * *

The possibility of introducing new plants and trees into the Sahara is to be explored by a botanical expedition led by Professor Chevalier of the French Museum of Natural History. A start will be made on the vegetation of southern Algeria and selected plants are to be taken with a view to their introduction in this region. The French botanists will also visit the

districts round Air and Lake Chad where the vegetation has not been studied before, and they expect to discover many new species. This expedition is the first of its kind and will be watched with interest.

* * * * *

The growing use of steel in building presents many new problems. The Victorian builder was not called upon to erect girders weighing seventy or eighty tons, and was not deeply concerned with yield points, stresses in riveted joints or connexional rigidity. But modern requirements call for a different technique, and hence the Steel Structures Research Committee was established. Its first report, just published, shows how valuable the application of scientific theory to practice has already proved. In these days of economy a reduction in building costs is of primary importance. A modern commercial building may contain as much as 7,000 tons of steel. Sir Clement Hindley, chairman of the Committee, explains that only complicated mathematical analysis, rigorously tested by experiment, can show how much steel is actually wasted by placing the load too high through lack of accurate knowledge. In using these vast quantities of steel, a comparatively small surplus may represent a loss of hundreds of thousands of pounds. The expense involved in research may therefore yield a profit of one thousand per cent. The Committee has undertaken an ambitious programme and time must elapse before the full benefits can be judged.

* * * * *

The discovery of a new material for gramophone records is announced. Hitherto a musical performance of any length has been interrupted by changing the record, but a complete symphony has been reproduced on a record made of the new material. Improvements must be made in the tone but the experiment was highly successful from a mechanical point of view. In the new record the sound tracks are shorter and set more closely, so that it plays for about a quarter of an hour instead of five minutes. The type of motor used in gramophones at present is inadequate but this can easily be improved. When certain defects have been corrected the new records should become very popular.

* * * * *

A deadly plant pest may become a source of income if the suggestion of an entomologist in Kenya proves practicable. A renewed attack is being made on the locust throughout Uganda, Kenya and Tanganyika, where the pest causes extensive damage to crops. According to *The Times*, enquiries are now on foot to discover whether there is a market overseas for "locust meal." If there is a sale for the food, a new means of attacking the pest will have to be found, for the present method of using poisoned bait would defeat its own ends. There are hundreds of square miles of elephant grass in Uganda, twice as tall as a man and almost impenetrable; breeding conditions are ideal and there is constant threat of renewed invasions in cleared areas. The Kenya government is calling upon everyone to help in the campaign, and has suggested that the swatting of locusts should become a "popular and fashionable pastime." To prepare the food the insect is dried and ground into powder. Feeding tests have been carried out on cattle without ill effect, while it is well known that production of eggs increases when poultry are allowed to feed on locusts. But this form of diet has its dangers, it would seem; for the story is told of a farmer who sent his hens out to feed on locusts and was amazed when they returned without their feathers!

* * * * *

The exhibition of optical glassware at the Science Museum is a reminder that bi-focal spectacles are not so modern as generally supposed. It was Benjamin Franklin's discovery that "the same convexity of glass through which a man sees clearest and best at the distance proper for reading is not the best for greater distances" that led him to devise in 1785 a pair of spectacles "with half of each kind of glass, least and most convex, in each circle." In a letter from France he wrote: "I had formerly two pair of spectacles, which I shifted occasionally, as in travelling I sometimes read and often wish to regard the prospects. . . . Now, as I wear my spectacles constantly, I have only to move my eyes up or down as I want to see distinctly far or near. This I find more particularly convenient since my being in France, the glasses which serve me best at table to see what I eat not being the best to see the faces of those who speak to me; and when one's ears are not well accustomed to the sound of a language, a sight of the movement in the features of him that speaks helps to explain; so that I understand French better by the help of my spectacles."

* * * * *

That the chemical contents of an average man could be purchased for five shillings is not, perhaps, a flattering reflection, but this is the estimate of Dr. T. E. Lawson. The body of a ten stone man contains among other chemicals, enough water to fill a ten-gallon barrel, enough fat for seven bars of soap, carbon for 9,000 lead pencils, phosphorus to make 2,200 match heads and sufficient lime to whitewash a chicken coop.

The " Rebel " Replies.

By Herbert Dingle, D.Sc.

Last month Sir Arthur Eddington reviewed Professor Dingle's book, " Science and Human Experience." His criticisms are answered in this article. " In taking the rather unorthodox course of replying to a perfectly fair review," writes the author, " I am actuated only by the conviction that the points at issue demand discussion."

SIR ARTHUR EDDINGTON, discussing my recent book, " Science and Human Experience " in *Discovery* for December, asks some questions which call for answer. But first I must express surprise at finding myself described as the " prosecuting counsel." In the passage on which this description is based I state clearly that I am a rebel anxious to justify, or at least to explain, his rebellion. Why Sir Arthur should thereupon rush into the dock and lose the power of detached criticism I do not understand. Can it denote an uneasy conscience? Hardly that; but it is a pity, because a detached attitude would, I think, have enabled him to see my position more accurately and have prevented other distortions of my meaning as striking as the conversion of a rebel into a prosecuting counsel! Let me explain.

[*Swaine*

PROFESSOR HERBERT DINGLE.

He says that I have not rightly diagnosed the source of my divergence from him. Perhaps: if I have ascribed to him views which he does not accept he is undoubtedly right, for he is the final judge of that matter. But I am not yet persuaded that I have done so. He says that his conceptual scheme is a scheme of connecting links *and nothing more*. What does it connect? My conceptual scheme connects observations. The connecting links are not observations but conceptions. I call them true if they connect observations by the laws of reason. I call observations true if they are agreed upon by all normal people. Clearly the two " truths " are of different kinds since they have different criteria; therefore what is true of linkages may not be true of observations.

For example, to make the linkages (electrons) true we must suppose them to be undetermined. Experience, however, tells us that sensible events are determined. Since both things need not be true in the same sense, this involves no contradiction. But Eddington, faced with this paradox, concludes that the observed determinism of the sensible world is illusory because the linkages are undetermined. Since he imposes the characteristics of the latter on the former, I attribute to him the view " that the conceptual scheme is in some sense ' truer ' than the world of experience." I am still unable to see that that is a false diagnosis. My answer to his specific question is: there is no difference so long as we confine ourselves to the linkages; the whole point is the relation between the linkages and the observations they connect.

Then there is that problem of the giddy elephant. The reason why I did not say that Sir Arthur was illustrating " exact " science was not that I wished to misrepresent him. The reason for my omission was two-fold: first, because the information was superfluous; second, and more important, because it was irrelevant. It was superfluous because the quotation itself contained it. It began: " If we search the examination papers *in physics and natural philosophy* . . . ," and culminated in: " And so we see that the poetry fades out of the problem, and by the time the serious application of *exact* science begins . . . " (italics are mine in both passages). The information was irrelevant because if the word " exact " is important the whole thing is trivial; it simply shows that in physics what we deal with are measurements. " There needs no ghost, my lord, come from the grave, to tell us this." I knew Sir

*

Arthur Eddington too well to imagine that he would waste so much ingenuity on the obvious, and discussed only his real contention, which was that when we separate out the metrical elements (call them science or exact science) we make the fundamental cleavage of the data. The other elements are included in the "poetry" of the problem. What I claimed was that among them were some that had closer affinity with the metrical elements than with the company he gave them. When I am asked to believe that biology is more akin to poetry than to physics, I rebel.

Theory and Observation.

Is the close contact of the quantum theory with observation and the comparative detachment of relativity notorious? If so it deserves its notoriety in the worst sense of the word. No one knows better than Sir Arthur (when he is not in the dock) that the great bulk of knowledge included in relativity was previously included in Newton's generalizations, and the detachment is apparent only because, naturally, popular attention has been directed to what is novel and extreme. But equally extreme applications of Newton's laws are imaginable. They predict the path of the cow in jumping over the moon, notwithstanding that Sir Arthur's elephant still holds the record for that kind of escapade. As for the quantum theory, who hath lost the position of an electron in measuring the momentum thereof? and the exclusion principle of Pauli, whose observation hath gendered it? Sir Arthur himself has distinguished the relativity from the quantum laws by calling them (with a proviso irrelevant here) laws of *identity*, whose violation is unthinkable. I think what I mean by abstraction is what he means here, but not being able to master his meaning with the completeness I wished I started to think the matter out for myself from scratch. I am not so presumptuous as to think my interpretation better than his, but it is more satisfactory to me.

What is the difference between the electrons in a Geiger counter and the stars on a photographic plate? Simply that there are, *ex hypothesi*, electrons in the counter but no stars on the plate, only star images. The parallel is between electrons and light, not stars. I accept it.

I do not admit that my sketch of the growth of hypotheses is misleading. Sir Arthur has missed my point. I did not suggest that our *acceptance* of hypotheses has become more assured and dogmatic, but that we are *readier to frame* them. I grant that in general we are sufficiently critical of them when framed. But Sir Arthur's objection is misleading because he ascribes Laplace's diffidence only to a particular hypothesis, whereas Laplace associated it with all hypotheses. Remove that misapplication and the objection disappears. Both Eddington and Laplace ask, "Where is truth?" Laplace asks, "Is it in observation and computation or in the product of purposeful imagination?" Eddington (speaking for modern physics) asks, "Is it in the macroscopic or the microscopic equations of physics?" Allowing for the development of science in the interval the questions are identical; but the answers are opposite.

I am not "determined to discover in the modern physicist an attitude of omniscience." I never suggested such a thing. I wrote of "a kind of omniscience in us," meaning by "us," as the context makes clear, the human race. The inhabitants of H. G. Wells's country of the blind rationalized their experiences without including the data of sight, on the principle that what was unobservable to them was non-existent. The seeing intruder recognized this as a rule of convenience only. Similarly, if there are beings with a sense additional to ours, they will recognize that our similar principle is a rule of convenience. If we say it is absolute we assume that we have all possible senses. I call that "a kind of omniscience." Perhaps it is a vile phrase, but on re-reading the paragraph I do not see how it can be misunderstood. Certainly only a megalomaniac "would publish a list of the things which . . . might exist without his knowing it," but who suggested such a list? Certainly not I.

Since determinism has been universally assumed in science until now, I should have looked for the apologia from those who deny it. Sir Arthur's apologia, as I have explained, I do not accept, because it applies only to the linkages and not to the things connected. But I have, in fact (p. 87), defined what I mean by determinism, making its truth obvious. I have specifically excluded (p. 88) any metaphysical notion of "cause" which might have required justification.

An Involuntary Rebel.

In taking the somewhat unorthodox course of replying to a perfectly fair and even generous review, I should like to say that I am actuated only by the conviction that the points at issue are important enough to demand such a discussion. There is no leader whom I would rather follow than Sir Arthur Eddington, but involuntarily I am a rebel. For the sake of readers of this discussion who have not read the book, I should add that I do not deny human free-will and that I do not object to the use of hypotheses but only to their misuse.

What is a Virus?

By A. E. Boycott, LL.D., F.R.S.

Director of the Pathological Department, University College Hospital.

Much progress has been made in recent years in our knowledge of viruses, the cause of many familiar diseases. Some of these minute particles are too small to be seen through the most powerful microscope; to discover their size, they are passed through a filter whose dimensions are calculated from the flow of air and water.

DURING the past fifty years most people have become familiar with the fact that a number of diseases are caused by microbes which are too small to be seen by the naked eye. These bacteria can, however, readily be seen with the help of the microscope; they can be isolated from the bodies of diseased men and animals and grown on suitable media by themselves; their multiplication can be watched, and by inoculating these pure cultures into susceptible animals the diseases from which they came can be reproduced.

Live Organisms.

We have also learned that other bacteria, which do not cause disease, are responsible for the various fermentations and putrefactions which are always going on in our world. Their nature can be verified in the same way: from sour milk a microbe can be isolated in artificial culture by itself, which can be seen under the microscope to divide and multiply, and which will turn fresh milk sour if it is added to it. No reasonably sceptical person can doubt that bacteria are live organisms, relatively simple it is true, but not essentially different from such organisms as rabbits or sunflowers; they are capable of independent existence, can multiply indefinitely and, in any ordinary sense, are the cause of the disease or fermentation with which we find them associated; it is, as it were, just an accident that they are beyond the range of our unaided sight.

During the present century, and especially in the last fifteen years, it has become increasingly evident that we must familiarize ourselves with an extension of this idea, and realize that the causative agents of many of the most important diseases of men, animals and plants are too small to be seen with the most powerful microscope which has been made or, if current theory is correct, possibly could be made. Nothing which looks like a microbe can be found microscopically in the fluid from a blister of foot-and-mouth disease in a cow or in the blood of a human case of yellow fever, yet these fluids will convey foot-and-mouth disease and yellow fever respectively if they are inoculated into susceptible animals or human beings, and they are still infective after they have been passed through filters of earthenware or collodion with holes so small that no particle visible to the highest powers of the microscope can get through.

By common consent these minute agents of disease are now known as *viruses*, which may or may not be a good name for them; it is at any rate understood, and some better term can be found when we know more about them. In their capacity of causing disease, the behaviour of viruses is in a general way on all fours with the behaviour of bacteria, and there is no obvious difference between the phenomena of diphtheria, typhoid fever and plague, which are caused by undoubted bacteria, and of chicken pox, measles and yellow fever, which are caused by viruses. In all instances the disease is caught by transmission of the causative agent from another case, either directly or through an insect intermediary. There is an incubation period, symptoms then declare themselves and are remarkably similar in broad outline; some persons die and those who recover are more or less resistant to reinfection.

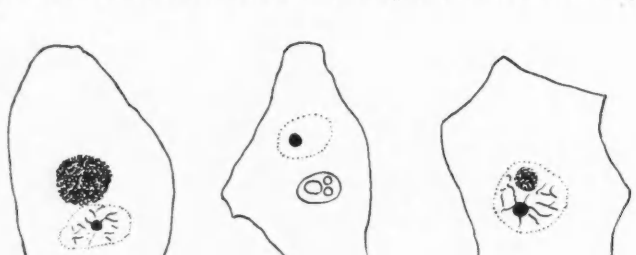
Judging from the facts of the disease, everyone assumed that chicken pox, for instance, was due to a microbe of the same nature as the bacillus which caused, say, diphtheria, and that our failure to demonstrate it objectively was due to its being for some reason unusually difficult to find microscopically and so particular about its conditions of life that it could not be grown outside the body. It was quite a reasonable inference and is so still, now that we realize the limitations of the microscope and know the reason why viruses are as a class invisible.

Many Problems.

There are, however, several considerations which make it difficult for us to be quite sure that this is the correct interpretation, though for practical purposes it is a good enough working hypothesis. In the first place, viruses are known only in association with diseases in live animals and plants; no virus has been found which causes fermentations or putrefactions in dead matter. This may mean

simply that all the members of the group are parasites.

Secondly, the fact that viruses can multiply is beyond question. Foot-and-mouth disease, for instance, can be carried on indefinitely from one guinea-pig to another by transferring a trace of the liquid from one of the blisters of the eruption, and in the ordinary process of protection against small-pox the vaccinia virus goes on year after year through rabbits, calves and children, increasing in quantity every time it is inoculated into an animal. But this multiplication occurs only in association with live cells or perhaps with cells that are recently dead, and no unequivocal success has yet been obtained in the numerous attempts which have been made to cultivate viruses on dead media such as suit bacteria quite well. Several observers have, however, obtained results which suggest rather strongly that success waits for the worker who has the inspiration or luck to try just the right culture medium. Some viruses will live for a long time away from living tissues, but under these conditions they do not multiply.



VIRUS DISEASES IN ANIMALS.

Cells in animal virus diseases (highly magnified) showing "cell inclusions" in the cytoplasm (A and B) or in the nucleus (C) representing aggregations of elementary virus particles.

Hence, as they are invisible, we do not know how they multiply. With an ordinary bacterium, the processes of division and growth can be watched under the microscope; we can, too, start an artificial culture with a single bacillus which will soon grow into a mass of bacilli easily visible to the naked eye. In this way we are pretty sure that the plague bacilli which we get out of the body of a rat inoculated with plague are the direct descendants of the plague bacilli which we put in. With viruses we have not got this fundamental assurance, and there is an alternative possibility which has been recognized since the earliest days of bacteriology—that the virus so affects the infected tissue cells that it causes them to produce more virus.

Bacteria which cause disease produce poisonous substances in varying degrees which either diffuse out into the surroundings or remain more or less closely associated with the bodies of the bacilli. Bacteria in sufficient doses are therefore always poisonous quite apart from their causing infection, as can be shown by giving animals dead microbes. There is no evidence that viruses are poisonous in this way, though this may be due to the bulk of substance which is administered being too small, and to their living in the body inside the tissue cells whereas the great majority of bacteria remain in between the cells.

Many people have found difficulty in believing that the complex phenomenon which we call life can be based on a thing so small as a virus. Viruses are certainly particulate, that is to say, the substance of which they are composed is divided into separate units. This is the same plan as prevails in the organic world, but we know now that the inorganic world is similarly constituted, so that the fact has no particular bearing on the question whether they are "really alive." As far as we know, they have no metabolism; attempts to show that they use up food material and produce excreta have so far failed. It would, however, be rash to base too much on results which may well be different when technique has been sufficiently refined. In effect, the conclusion that they are alive is based on their capacity to multiply, which is unknown in what we call non-living or dead. Till viruses came into knowledge, the smallest known particles which had the characteristics of live organisms were minute bacteria about 1/25,000th inch in their largest diameter, which is just about the limit of ordinary microscopic vision.

The size of viruses is evidently variable; some, such as vaccinia and parrot disease, are, as Ledingham has lately shown, fairly easily visible, at any rate at some stage in their life history, and there is no great difficulty in attaching "life" to them. For the sizes of those which are never visible, we have to resort to the indirect method of determining what filters they will not go through. The method is dubious and far from satisfactory; we know the sizes of the holes only from calculations from the flow of air and water through them, and it is not certain that the theory of the calculation is sound. It also seems obvious that a soft flexible organism might crawl or be dragged through a tube a good deal

smaller than its natural diameter when it was free in a liquid medium. On the other hand, in the excessively fine tubes of these filters there is a great tendency for particles to be held on the walls of the tubes when, if size only were concerned, they might easily pass through.

I mention these technical points because it is necessary to realize that sizes of this order cannot at present be determined to any high degree of accuracy. But taking all the difficulties and uncertainties into consideration, there appears to be no escape from the conclusion that the virus of foot-and-mouth disease (which happens to have been studied pretty thoroughly) is about five times the size of the molecule of haemoglobin, the red colouring matter of our blood. Most people find it difficult or impossible to believe that the complex activities of "life" can be carried on by an "organism" which can contain so few of the complex protein molecules on which "life" seems always to depend.

There are two ways of meeting this difficulty. It is possible on the one hand that each virus particle of which we measure the size does not include the whole organism, and that in filtration experiments the virus goes through because it goes through in pieces which have to reunite physically or at any rate co-operate functionally before they can produce their characteristic effect. We know by direct observation that a single bacillus is a complete whole; we have not the least evidence that a single particle of foot-and-mouth disease virus, for instance, can cause the disease or multiply or indeed do anything. If we assume that manifest activity depends on a dozen or a hundred particles working together, we need not worry ourselves too much about the minuteness of each one of them. There is indeed a little evidence that something of the kind actually occurs, for in the tissues in a number of virus diseases large bodies are found, easily seen with low powers of the microscope; and Barnard has given good grounds for thinking that these are agglomerations of virus particles embedded in some matrix.

On the other hand, it is possible that we are not altogether right in looking at bacteria as the patterns or analogues of viruses, and that we should do better to reflect on their similarity to simpler unorganized substances. Tissue cells contain substances which promote cell growth and which are set free especially when cells are injured or destroyed. If cells are stimulated to grow by a tissue extract containing these substances, more cells are produced from which larger quantities of effective extract may be obtained. Looking only at the beginning and end of the process, we observe that a small amount of growth-promoting substance is put in and a larger amount taken out; the substance has the appearance of having "multiplied." But we know in this instance that "multiplication" has not been direct; the particles we get out are not the lineal descendants of those we put in and their increase is due to their having stimulated cells to produce, or to be in a position to produce, more of themselves. No one would think, on these grounds, of calling growth-promoting substances "alive," and yet the phenomena of their existence are singularly similar to those of the smaller viruses.

TOBACCO PLANT.
A curious formation in a leaf of the tobacco plant, caused by the presence of virus disease.

It seems most likely, too, that the invisible agents which are associated with some malignant tumours are of this nature. There is no suggestion in the natural history and occurrence of cancer that the disease is brought into the body from outside by an agent in any way like the agents of the infectious diseases, and though constitutional factors play a part in determining its incidence it is essentially a local disease.

Tumours occur not very rarely in fowls—their discovery associated particularly with the name of Rous, their investigation with that of Gye—which may be transmitted from one bird to another by the inoculation of an extract which has been filtered through a fine filter and is microscopically void. The tumour cells, that is, produce some substance which can pervert normal cells and cause them to take on cancerous qualities; these cells in their turn produce more of the substance and so on. Looking back into the earlier history of cancer research in the light of this new knowledge, one sees that some older observations indicated the existence of

such substances but not in such a demonstrative way that their significance was appreciated.

Lastly, we have the "bacteriophage" discovered by Twort and d'Herelle, which occurs in particles which are, by the ordinary methods of filtration, as small as those of any virus. It makes itself manifest by killing and dissolving bacteria. It may be separated from a culture of bacteria by passing the liquid through a fine filter which keeps back the bacteria and allows the bacteriophage to go through. In this filtrate nothing can be seen microscopically, and when some of it is added to a culture of the same bacteria they soon dissolve. Each strain of bacteriophage is especially potent in acting upon the kind of bacillus from which it was derived. Separated from bacteria in a filtrate it will survive for a long time, but as far as we know under these conditions it has no activity and does nothing.

D'Herelle considers that the bacteriophage is an ultra-microscopic parasite of bacteria capable of existing as an independent organism. It is generally obtained from intestinal contents or sewage, but it has now been observed a good many times to appear, apparently spontaneously, in old cultures of bacteria, and most of those who have made a special study of the subject agree that it comes from the bacteria themselves; why, we do not know.

There are then many reasons for looking on the viruses which cause measles and chicken pox and other familiar infectious diseases as nothing more remarkable than very small bacteria which live continually as parasites. Such an interpretation seems to be fully adequate for practical hygienic purposes. But it is quite possible that it misses their wider significance. It is idle to dispute whether a thing is "live" or "dead" as if these were the only possible alternatives. There is no reason why there should not be, and many reasons why there should be, intermediates connecting one with the other, and it is quite likely that they are represented by viruses in so far as we have apprehended their existence at all. At the one end we have the larger viruses which cause disease and which may fairly be called "alive"; from these we pass downwards through the smallest viruses, whose position is dubious, the bacteriophage and the cancer agent to the simple growth-promoting substances, which in common language are certainly "dead."

Early Man: A New Discovery.

THE discovery of stone implements and traces of fire in a Chinese cave enhances enormously the importance of Peking man. This is the earliest known instance of the use of fire, and his ability to make stone implements indicates that Peking man was definitely human. Before these humanly worked pieces of quartz and quartzite were discovered, the only suggestion that Peking man was capable of making and using stone implements was a piece of quartz found in a fossil deposit. This was a rock which does not occur in the immediate neighbourhood. Four years of intensive search failed to produce any corroboration. Now a deposit of quartz has been found in the original cave, and over two thousand worked and unworked stones have been taken from a neighbouring site. These were associated with fragments of human remains, implements of bone and deer's antler, and large mammalian bones split to extract the marrow. They have now resolved all doubts. It is stated on the authority of the Abbé Breuil that Peking man used the split skulls of animals as drinking cups.

The implements found in the Chinese caves are said to be comparable with the Chellean and pre-Chellean of the European Stone Age, as well as with the implements made by the now extinct Tasmanians. It is startling to find that the latest discoveries in East Africa suggest an unexpected antiquity for "modern man." The East Africa Archaeological Expedition, of which Mr. L. S. B. Leakey is leader, has been engaged in an examination of the fossil beds in which that early specimen of *homo sapiens* was found. It has succeeded in establishing that Oldoway man is contemporary with the "Upper Kumasian" deposits of Kenya, in which occur implements of Kenya Chellean and Acheulean type. It has also found stone implements in all the successive strata of the fossil beds of Oldoway. About fifty per cent of the fossil fauna of these beds are extinct. Further, the succeeding types of stone implement shows a complete developmental series, extending from pre-Chellean to advanced Acheulean. Geologically the beds belong to the Lower and Middle Pleistocene; while the beds to which the skeletal remains belong have produced implements of advanced Chellean and early Acheulean type. It would thus appear that from East Africa comes the earliest specimen of *homo sapiens* yet discovered.

Brighter Museums.

The new Children's Gallery at the Science Museum marks a notable step forward in the movement for brighter museums. The exhibits are described by a correspondent who suggests that this example might be followed elsewhere.

How often has the promise to be taken as a treat to a museum struck gloom and depression into juvenile hearts? The Zoo is always a joy, and so is Madame Tussaud's, but a museum meant long galleries of unintelligible information, neither sought after nor desired.

Gradually this state of things has to a certain extent improved, and museums are nowadays very much less a collection of that which is past, than a continuous exhibition of both past and modern developments. Especially does this apply to the Science Museum in South Kensington, the deserved popularity of which is shown by the number of its visitors. But the Science Museum has not been content merely to provide instruction for the adult; the interests of younger visitors has not been neglected, and hence the Children's Gallery, which has for some time been in preparation in the basement of the Museum.

The aim has been to avoid a collection of isolated objects and to attain a continuity of thought in one line or another. For instance, on the right as you enter the gallery is a series of illuminated perspective scenes, illustrating transport through the ages. The first of these shows a primitive man carrying home on his shoulders the beast he has killed. This is followed by one depicting a party of Swiss lake dwellers dragging a deer on a sledge to the side of the lake, where their long "dug-out" canoes await them. The visitor then comes to animal transport, represented by a caravan of Thibetans crossing a Himalayan pass with their laden yaks. Ancient Egypt is next in the series, and here is a colossal statue being hauled on rollers by a gang of men. The Roman scene has almost a modern appearance; a horse-drawn dray is being loaded at a quayside from a merchant vessel moored near.

The First Balloon.

Thus the scenes pass through the ages, from pack-transport to eighteenth century coaches, the first air balloon and the beginning of steam transport.

On the other side of the gallery is a fascinating series of illuminated scenes, depicting lighting through the ages. It begins with a cave-dweller, holding aloft a firebrand. Next comes a scene on Hadrian's Wall as described in "Puck of Pook's Hill," with Roman soldiers gambling by the light of an oil lamp. Above are two lamps actually found at Philae in Egypt. In the next scene Prince Arthur has a tallow dip to light the prison cell, while a typical Victorian drawing-room is lighted by a colza-oil lamp of 1860-70. Incandescent gas is shown lighting a tailor's shop. Then comes electricity, the first type being an early arc-light hanging from the roof of a warehouse. The final stages of electric lighting are the ordinary filament bulb and the more modern concealed lighting and illumination by vapour tubes. These are illustrated in the scene of a sculptor's studio.

Illuminated transparencies portray the work of the astronomer and chemist at different periods, and the development of the aeroplane.

A Wind Channel.

There is also a wind channel where the lift of the aeroplane can be seen by turning on an air-current. In other cases models illustrate the development of the modern boat from the primitive dug-out canoe, and working models show various methods of measuring time before pendulum clocks were invented.

At the far end of the gallery are three bays which will contain full-size reproductions of a nailmaker's forge, a potter's wheel and a flint-knapper from Brandon in Suffolk (the last of the trade). Films showing each of these at work will from time to time be shown. Another bay is devoted to the subject of lifting, and contains examples of a pulley, pulley-block, windlass, lever, inclined plane, screw-cantilever and hydraulic jacks. All these are working models, and there is also one of a large electric overhead travelling crane, shown in its appropriate workshop, through the end of which appears a dockyard scene including six different types of cranes.

This gallery was opened to the public on 12th December.

Surely such an exhibition need not be confined solely to the Science Museum? Among the many beautiful and interesting collections of other museums, could not a large amount of material be found suitable for furnishing a similar gallery? Children are extremely intelligent and appreciative, and incidentally are highly critical. Not having reached the age when it is necessary to dissemble one's feelings, they may be relied upon to voice their opinions. This is as it should be; and any reasonable suggestion regarding the Children's Gallery will most certainly be considered by the authorities of the Science Museum.

M. H. L.

The New Era in Farming.

By C. S. Orwin.

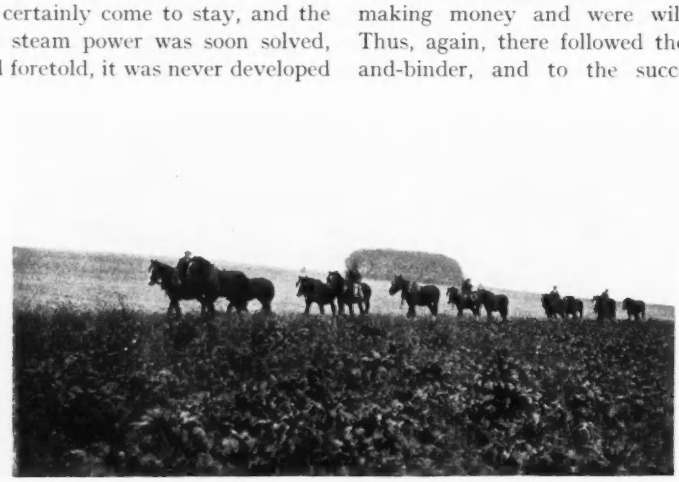
Director of the Agricultural Economics Research Institute, Oxford.

The future of mechanical methods of farming is here discussed. Many remarkable labour-saving machines have been evolved in recent years, but the author suggests that a wider use must be made of them than is now the case if corn growing is to continue as an important branch of British farming.

ANYONE interested in the progress of agriculture, whether at home or abroad, must have observed the frequency of references in the past year or two to mechanized farming, and not a few may have seen one or more of the Russian films which illustrate the lengths to which that country has gone in its attempts to apply a factory organization to farming.

In England mechanization of farm processes is no new thing. It is just eighty years since Léonce de Lavergne, a Frenchman, travelling in this country to study its agriculture, commented in "The Rural Economy of England, Scotland and Ireland" upon the employment of steam engines on English farms. Before 1848, he said, very few farms possessed them, whereas in 1851 "smoking chimneys are to be seen in all parts of the country. These steam engines are used for threshing corn, cutting fodder and roots, grinding cereals and oil-cake. . . . Movable steam engines go from farm to farm like a labourer, to do heavy work. . . . Some have even undertaken to plough by steam, and do not despair of success."

Although the substitution of steam for manual and horse power had certainly come to stay, and the problem of tillage by steam power was soon solved, as M. de Lavergne had foretold, it was never developed generally throughout the country for agricultural purposes; its use was more or less restricted to the performance of certain operations, of which tillage and threshing were by far the most important. For practically all other kinds of work, horse labour and manual labour held the field.



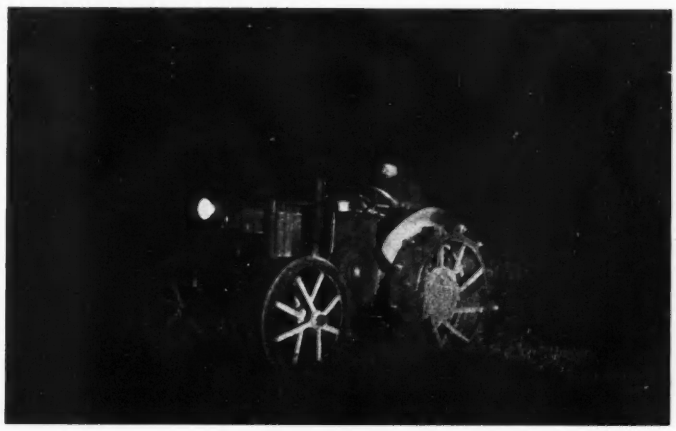
OLD METHODS——

Ploughing teams going home at three o'clock at the end of a day's work. Twelve horses and six men are employed in ploughing five acres.

This is not to say that the mechanization of farming processes made no progress. On the contrary, from about 1850 onwards, if progress in power farming was slow, agricultural history records a succession of inventions, many of which were applied generally throughout the land, designed to speed up agricultural processes by the application of horse power to work previously performed by hand. The plough, of course, had replaced the spade many centuries before, and a few implements such as the horse-hoe and the drill had already made their appearance. But it was not until the revival of agriculture about the middle of last century that the invention of machines to increase the efficiency of labour was speeded up, and it remained for days of adversity to give the latest fillip to invention by reason of the necessity for reduction of costs.

Thus is seen the introduction of barn machinery, operated by the horse-gear, for the preparation of cattle food, the coming into general use of the reaper, invented in 1826, and of other machines, all of which belong to the period of prosperity which terminated in the 'seventies, when landlords and farmers were making money and were willing to adventure it. Thus, again, there followed the resort to the reaper-and-binder, and to the succession of hay-making machines which revolutionized the processes of hay-making in the depressed days of the 'nineties, when everything had to be tried which would reduce costs. And so on to the present time, when the petrol engine has replaced the horse-gear, the milking machine is cutting out the hand milker, and

the tractor is replacing the horse team as the motive power on the land. The tendency towards mechanization has been continuous for nearly a century, with peak points apparent, perhaps, during times both of elation and of depression in farming fortune.



—AND NEW.

A tractor still at work at eight o'clock in the evening. Two men are employed and fifteen acres are ploughed and drilled.

But with the exception of steam cultivation, the extent of which must have declined very considerably with the decline in the area of arable land, and particularly of the heavier ploughland, all the developments have been in the invention and design of labour-saving machinery for horse-draught. Power farming, as represented by the substitution of the internal combustion engine for horse labour, is only now being thought about for the first time in this country.

The impulse came first, and still comes, from the new countries, were land is limitless and labour lacking. Until the introduction into North America of the reaping-machine, the repeal of the Corn Laws had no reaction on wheat imports, for the prairie pioneer could occupy no more land than that which was necessary to grow the bread food for himself and his family. The introduction of the reaper from England wrought a revolution, in that it brought about an immediate and immense extension in the area which one pair of hands could harvest. The next development, the reaper-and-binder, and all the mechanical inventions for the reduction of labour costs which have followed it during the sixty years since its appearance, have come from the new countries, where labour, not land, is still the limiting factor, by contrast with England, where these conditions are reversed, and where, prior to the Agricultural Wages Board set up in 1917, the human machine was the cheapest at the farmer's disposal.

The horse-drawn reaper released the labour formerly required for hand cutting; the reaper-and-binder, still horse-drawn, released the labour spent on tying the corn into sheaves; the application of the internal combustion engine to farm traction multiplied the speed of all land operations from ploughing up to harvesting six or eight times, by the elimination of the slow-moving, less powerful horse-team. And lastly, the introduction of the combine-harvester—a machine in which a reaper is attached to a portable threshing machine and the whole is drawn by a tractor through the standing corn, leaving a trail of sacks of threshed grain and another of straw in its wake—has made a still further extension of the work which one pair of hands can encompass, by the elimination of the labour on stooking, carting, stacking and thatching the crop.

So in a country where land is limitless and labour is scarce, each one of these changes has increased the output of the individual and reduced the unit cost of the product. From 160 acres, which was once the size of the standard one-man farm in the prairies, the area has now been raised to something approaching 1,000 acres. Even though the present selling price of wheat is probably below that at which any margin is left for the producer, the reduction in costs following on the complete mechanization of processes by the prairie farmer is having a profound reaction on the position of the cereal grower in England. In fact, the only alternative to the adoption of the methods of his competitors (leaving out, of course, any question of political action) is for him to abandon the business.

What is the scope of power farming in England? Its great extension in other countries is confined in the main to arable farming, for obvious reasons, and it is in connexion with arable farming that expansion will come in this country. The most important problems which confront the arable farmer to-day are the comparatively recent one, that of labour costs, and the age-old one, the weather. Each of these is outside his direct control, and stands as a challenge to his skill in mitigating its effects by his technical efficiency. Until the war, wages were fixed by the freemasonry of farmers at levels well below those of industrial wages, except perhaps in districts and at times when agriculture and urban industry came into direct competition. To-day, wages are

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fixed for the farmer by an independent tribunal after he has had an opportunity of stating his case; and weather is sent to him without his being heard at all.

It is no use to complain of these conditions. A high standard of living has long been a national ideal; it is determined by public opinion. Whatever the handicap that it may impose on the home producer faced with competition from countries where labour conditions are unregulated, it has got to be met. It is of the first importance, therefore, that the farmer should secure the highest possible output from every man employed, while it is obvious that everything that can be done to speed up the execution of farm operations will make him more independent of unfavourable weather conditions.

Nothing could do more towards the attainment of these ends than the substitution of power for horse and hand labour. A man with a spade can dig an acre in about twelve days; with a pair of horses and a plough he can do the same work in a day or a day and a quarter; but with a modern tractor and multiple plough he can turn over the soil at the rate almost of an acre every hour. Moreover at busy seasons, when it is of importance to do work at speed so as to take advantage of a spell of fine weather, the power farmer is not limited by the physical capacity of horses. By small overtime payments to his men, or by working in shifts, his power implements can run all the hours of daylight, and they may even be operated in the dark hours of the evening and before the dawn, as the accompanying illustration shows.

TRACTOR WITH PLOUGH AND DRILL

With a modern tractor and multiple plough the farmer can turn over the soil at the rate of almost an acre an hour. A typical modern machine is shown.

No one can tell at present what are the sum total of the economies which the extension of power farming will introduce. At present, very few farms have been equipped with a complete mechanical outfit. Tractors are used in numbers, but usually as an adjunct to the normal horse equipment. In too many cases, the machines they draw are horse machines adapted for mechanical draught by some makeshift attachment; they are too small in themselves to realize the full efficiency of the additional power, nor are they constructed to withstand the wear and tear of the greater speed of working. And so power farming has not yet had a trial, and reliable data cannot be produced in quantity sufficient for the information of all those who are able and willing to make the change from the older methods.

It follows that no one can dogmatize at present upon the limitations of power in farming. It is often urged that tractors are no use on heavy land, or even on some of the lighter lands which turn sticky after rain. But will it be necessary, when the possibilities of power farming are fully realized, to work on heavy land when it is wet, or on light lands when they are sticky? Will not the ability to do work at speed make it possible for the farmer to plough and cultivate many soils which are regarded nowadays as difficult to work in a wet autumn or a catchy spring-time?

By mounting a seed drill on top of a five-furrow plough pulled by a crude-oil tractor, a Wiltshire farmer is able to plough and plant fifteen acres of oats a day, working two shifts of eight hours each. A Hampshire pioneer of power farming was able to cut and thresh 32 quarters of wheat in an afternoon and evening, setting to work with a combine-harvester at 12.30 p.m. after one inch of rain had fallen in the morning. The grain, of course, had an immensely high water content, which would have made it useless for any purpose under ordinary harvesting processes, but in the artificial drier which forms an essential part of the power farming equipment in this country of uncertain weather, it had been reduced to good milling condition the same night, as certified by the Milling Association. And another Hampshire farmer, who harvests the crops on 250 acres of plough land by power machinery, had garnered his corn in the difficult harvest weather of last summer and ploughed no less than 60 acres of his stubbles before the middle of the month of September.

These experiences are indications of what may be expected by the extension of power to arable farming

processes, both in raising the output of labour and thus reducing cost, and in rendering the farmer independent of the seasons and the vagaries of the weather. Although very few at present, results such as the foregoing are so striking and so convincing that the question must arise, why is not the conversion from horse labour to power farming proceeding apace? The answer is that traditional systems of farming, from which the newer countries where power farming is rapidly extending are free, impose restrictions on its development which can only be removed in some cases by the expenditure of capital, and that the economic conditions of the times are against the employment of capital in the reconstruction involved.

Take, for example, the question of equipment. The evidence is that it costs no more to equip a farm with the necessary tractors and tractor-drawn implements than with the customary outfit of horses and the gear appropriate to them. Certain figures can be produced to convince the farmer of the saving in labour costs and the increase in general efficiency of labour which would result. But what is he to do? He has a full complement of horses and horse implements, useful for their purpose but worth very little if thrown upon the market to provide capital for the new equipment, and such reserves as he may have accumulated in better times have been dissipated in the last few years.

MECHANICAL FARMING IN RUSSIA.
A factory organization is being applied to farming in Russia. A scene from the film "The General Line," reproduced by permission of Atlas Film Co.

Again, it is only true to say that the capital cost of a power equipment is no more than that of the older-fashioned outfit, if it be granted that it is to be applied to a farm large enough in total extent to keep it fully occupied, and made up of fields suitable for mechanical cultivation without loss of time. The experience available shows that this means farms with not less than some 500 acres of plough land, comprised in fields of not less than 30 to 50 acres. The modern mechanical equipment will not find full scope on a holding of less size, or in fields of less acreage, and how many farms are there throughout the arable districts of England which come up to this specification? Probably only a small proportion of the whole, and so both difficulties will be encountered and expense incurred if farms are to be reassembled in larger units and if field boundaries are to be readjusted.

These are the limitations imposed on the development of power farming in this country, limitations which the prairie farmer does not know. But with the accumulation of experience and the pressure of competition, it may be expected to develop more rapidly, perhaps, than seems likely at the moment. It will involve collaboration between landowners and farmers and between farmers and their banks, to bring about the necessary changes in holdings and in equipment. It may lead even to co-operation between neighbours or small groups of farmers, to share in the equipment required for which individual holdings are too small. Or contractors may see an opportunity in the new machinery to undertake cultivation, combine-harvesting and crop-drying at a scale of charges, on the analogy of the steam plough owner and the threshing-machine owner. These are speculations, but what is certain is that power farming must come if corn growing is to continue as an important branch of English farming. It has passed the experimental stage and its possibilities, technical and economic, are understood.

Greater revolutions than those that are represented by the application of power have passed over the farming industry before now, and others greater still will doubtless break upon it in the future. The evolution of urban industries has proceeded at a rate and to lengths to which nothing in agriculture can approach, and there is a tendency to look upon farming as something apart, something to which the laws which have controlled the economic development of other enterprises do not apply. Some concessions must be made to a traditional industry, in which changes are effected more slowly than in those which have no history; but the only alternative to change is stagnation.

International Polar Research.

By Frank Debenham.

Director of the Scott Polar Research Institute.

Fifty years after the first Polar Year, a second international attack on Arctic meteorology and magnetism is planned for 1932-33. Preparations are now being made in several countries. The work of the British party will include a study of the stratosphere by means of balloons carrying self-recording instruments.

It was Karl Weyprecht, the Austrian explorer, who in 1875 first conceived the idea of a concerted effort in the polar regions by a number of nations, and who put it before certain German scientific societies to such good purpose that the scheme grew rapidly.

Fifty Years Ago.

The middle of the nineteenth century had been, largely owing to the prolonged search for Franklin, exceedingly rich in polar discovery, but in spite of this, comparatively few scientific results had been forthcoming. Weyprecht attributed this to the fact that most of the then recent expeditions had been merely out to attain a higher latitude than their predecessors, subordinating all else to the covering of the largest possible tract of country.

But while advocating more attention to the scientific side of discovery, Weyprecht realized that a few isolated and spasmodic observations were of little use, and thus came into being the idea of a year of continuous magnetic and meteorological observations, to be made with identical instruments, at specified times simultaneously from a circle of stations round the Arctic. The project was taken in hand by two international congresses, at Hamburg and St. Petersburg, plans were worked out in detail, and finally in 1882-3 twelve nations sent parties into the field, to occupy observing stations in or close to the Arctic Circle.

It is interesting to compare the work of 1882, and the stations occupied then, with the plans for next year. The programme will follow the same general lines, and as far as possible observations will be made from the same stations as before. The chief difference as regards the actual expeditions will be that, owing to the greater accessibility of most of the stations at the present time, parties of four or five will be able to go where a whole ship's crew had to be sent fifty years ago.

At present plans are still somewhat uncertain owing to the universal financial crisis, but it is definitely planned that some of the countries shall occupy their former Polar Year stations. The United States will send a party under Captain Flavel Williams and Dr. H. B. Maris to Fort Conger, Smith Sound, the site of the most famous of all the stations occupied in 1882, where the expedition under Greely was marooned, all except six dying of starvation. The Williams-Maris Expedition, however, is to retain the ship at the base during the winter, and is also taking two aeroplanes, so that there is no risk of any repetition of the tragedy. The other United States Polar Year expedition was at Point Barrow under Lieut. Ray, who carried out the scheme according to plan. This station will be established again, as well as others at Nome and Fairbanks.

Russia has entered into the Polar Year scheme with great enthusiasm, for it fits in with the new plan of the Soviet Government for the economic expansion of her northern coastline. The Soviet will be responsible for the region between Nova Zemlya and the mouth of the Lena, and the approximate sites of her stations of 1882 will again be occupied. Sweden and Austria will also make observations from their former bases, the one in Spitzbergen and the other on Jan Mayen, using the huts built for Captain Wohlgemuth, who was leader of the expedition there in 1882. Norway has drawn up a large programme of work, which includes magnetic stations at Hammerfest and Kautokeino. Poland and Iceland will have their local stations, Denmark will provide for observations in Greenland, and Finland will establish a party at Sodankylä. Holland, whose venture in 1882 ended in the loss of her ship on the way to her projected station at Port Dickson in Siberia, hopes to set up a base on the east coast of Greenland.

The French Party.

A French party is to be at work at Scoresby Sound and Dr. Jean Charcot went there this summer in his famous ship the " Pourquoi Pas? " to carry building materials and make arrangements for the expedition. France also contemplated similar stations at Kerguelen and the island of St. Paul in the Indian Ocean, but

it is now doubtful whether this will be possible. The Argentine Republic and the Dominion of New Zealand hope to establish stations in the Sub-Antarctic islands, but unfortunately there will be no parties on the Antarctic continent itself. In the Arctic, therefore, there will be stations in Russia, Finland, Norway, Spitzbergen, Jan Mayen, Greenland, Ellesmere Land, Canada, Alaska and Siberia, and the circle of observations round the North Pole seems to be assured.

The Polar Year is to be the means of the simultaneous investigation of the following problems: the general circulation of the atmosphere in Polar regions, both at ground level and in the upper atmosphere (little is known about the height and temperature of the atmosphere within either Polar Circle); terrestrial magnetism and the aurora. Such problems require for their solution simultaneous observations over a large area, and the Polar Year parties intend to concentrate upon these, and not to undertake any sidelines which could be investigated by single expeditions at any other time with equal success. Some of the countries taking part will pay special attention to geophysical work at home, instead of sending parties to take up their station in the Arctic. These observations will be nearly as important as those made in high latitudes as their object will be to discover the effects of specified polar conditions on the physics of the rest of the world.

In England it is natural that special interest should centre round the expedition to Fort Rae, which will be the most important of the British Polar Year activities; an observatory on Ben Nevis is also planned should funds be forthcoming in time to erect a building. Fort Rae is a settlement of the Hudson Bay Company on the northern arm of the Great Slave Lake in lat. 62° 50′ N., and although it is not within the Arctic Circle it is situated near one of the two "Poles of Cold" in the northern hemisphere, the other being in Siberia; the winter has temperatures as low as 100 to 110 degrees below freezing point on the Fahrenheit scale. A party was stationed at Fort Rae during the First Polar Year, but this was at the Old Fort, seventeen miles farther south.

It is an ideal place for observations of this kind which should be representative of a large continental area. The country round is flat and consists of muskeg swamp and a dense bush of low-growing willows, this giving place to open tundra about fifty miles to the north. The nearest hill, which is only five hundred feet high, is eighteen miles away, so that meteorologically the site is practically perfect. For terrestrial magnetism it is not quite so good as there are considerable magnetic anomalies in the neighbourhood; but it has an interesting position for the observation of the aurora, being close to the zone of maximum auroral activity. Some of the most important work carried out will be investigations of the stratosphere by means of balloons carrying self-recording instruments.

The coast of this branch of the Great Slave Lake is fringed by a series of small islands on one of which the Fort Rae settlement is built. The island is of bare red granite and only twenty feet above the surface of the lake. The British party will live there in log huts except for periodic visits lasting several days to the Old Fort, for the photography of the aurora and other observations to be carried on simultaneously with those at the main station. There is a large Indian encampment at Fort Rae during the summer, though at other times the only neighbours of the

[*Royal Canadian Air Force Photo*

THE BRITISH STATION AT PORT RAE.

The British party will occupy the rocky island in the centre of the photograph, marked with a cross.

British party will be a Roman Catholic missionary, the Hudson Bay Company's manager, two other traders, and the R.C.M. policeman.

The Fort is cut off from civilization except for six weeks during the summer, and the only means of transport will be by canoe and dog-sledge; there are Indian trails through the bush. The British party will be led by Mr. J. M. Stagg, a senior professional assistant at the Meteorological Office, and will leave for Fort Rae early next May. It will carry on its work from 1st August, 1932, until 1st August, 1933, the period which constitutes the official Polar Year.

The party of five or six men will be continuously occupied with the routine observations, but though isolated, they will find no time for monotony. Physicists will recognize that the more automatic and self-recording an instrument is, the more attention it needs, especially in extreme cold, so that the mechanics of the party will be kept busy. The measurements of the height of the aurora will involve simultaneous observations at the main and at the sub-station, seventeen miles away, and these will require very careful planning. The search for the instruments dropped from the balloons will provide some excitement and hard travelling over the lake ice, and fishing may afford occasional relaxation from technical duties. As the air photograph shows there is little of interest in the landscape itself, but we can safely say that the party will not suffer from ennui with such a large programme to carry out.

It is most unfortunate that the second International Polar Year should coincide with a world-wide financial depression, so that plans have had to be cut down severely. Nevertheless it is confidently expected that the combined results of these expeditions will go far to solve some of the major problems which occupy the minds of meteorologists.

Exploring Unknown Lakes.

A BIOLOGICAL survey of hitherto unexplored lakes in Kenya and Uganda has been carried out by an expedition from Cambridge under the leadership of Dr. E. B. Worthington. The expedition has thus completed the work on the Greak Lakes of Africa which was started by the government fishing surveys in 1927. The work included a study of the almost unknown Lake Rudolf in the desert region of Northern Kenya, bordered by the Sudan and Abyssinia.

Describing the work of the expedition in *The Times*, Dr. Worthington states that the fishes of Lake Rudolf are remarkable for their abundance and variety, and among the collections brought home it is expected to find a number of kinds unknown to science. The fish of economic importance is called the ngege, a carp-like species which is found in Lake Victoria. But the ngege lives only near the shore-line in shallow, papyrus-fringed gulfs. In the open waters there are fish in any numbers, but small species. These, though valueless in themselves, would afford a magnificent food for a large predacious fish if such existed, but at present there is no such fish in Lake Victoria. In other lakes, however, such as Albert and Rudolf, there exists just such a fish, easily caught and excellent eating—the great Nile perch. It has therefore been suggested from time to time that the Nile perch should be introduced to Victoria; but Dr. Worthington points out that such a step could not be taken without exhaustive research into its results, because the Nile perch might eat up the ngege, and so ruin the present fishery.

Now at last the opportunity of testing the results of this drastic proposal offers itself in a little lake which was investigated during the last year. This is Lake Nabugabo, which occupies an area of about 12 square miles near the north-west shore of Lake Victoria. After the Nile perch have been introduced to Lake Nabugabo, it is pointed out that a year or so should be sufficient to show whether they will establish themselves. If they do so, one of two things must happen: either they will multiply enormously and eventually eat out their food supply and so die out themselves, or they will strike a natural balance with the other fishes.

In making such changes in the fauna of our Colonies Dr. Worthington explains that due precautions must be taken. Before introducing a fish to any lake a thorough biological survey should be made, lest the introduction should result in losses to zoological science of unknown organisms, even of the most microscopic nature. It must be ascertained that the introduced fish cannot spread to other waters; there are countless examples of rash introductions in the past which have led only to disaster. Above all, such experimental work should never be carried out without adequate supervision and control by someone who is versed in fishery problems. Dr. Worthington will describe the work in more detail in next month's issue.

Bülow's Memoirs.—II.

England and the German Fleet.

By R. B. Mowat.

Professor of History in the University of Bristol.

Concluding his review of Bülow's "Memoirs," Professor Mowat discusses the events of the years 1897-1909, the period of the second volume. These were perhaps the most momentous years in Anglo-German relations, for they saw the Tirpitz naval programme established and the building up of the German fleet.

THE excitement created in Germany by the publication of Prince Bülow's "Memoirs" has been intense. The Germans feel that this statesman whom the State had so highly honoured and rewarded has now, speaking from the grave where no one can answer him, signally damaged the good name of the German Government and people. Numerous critical articles have appeared in the Press and now books are being published. Soon there will be a whole literature of "Bülow-criticism." Already, an important book has appeared. It is called "Fürst Bülow's Denk-Unwürdigkeiten" (in allusion to the German title of Bülow's Memoirs, *Denkwürdigkeiten*, or "Things worthy of remembrance"), by Edgar von Schmidt-Pauli.

Criticisms in Germany.

A remarkable recent article is "Zum Psychologischen Verständnis von Bülow's 'Denkwürdigkeiten'" ("Help towards a Psychological Understanding of Bülow's 'Memoirs'"), by Pauline Countess Montgelas, published in September, 1931. Here the view taken is that Bülow's unpatriotic, un-German memoirs are to be explained by two facts: one, that besides the stern, strong, military or bureaucratic type of Prussian, there is a cultured, cosmopolitan type, and it was to this that Bülow belonged. The second explanatory fact is inferred from Bülow's approving quotation of Talleyrand's remark: "Qui n'a pas vécu avant 1789 n'a pas connu la joie de vivre," or as Bülow would have rendered it: "No one who has not lived before the French Revolution has any idea how sweet life can be."* This, according to Countess Montgelas' interpretation, means that Bülow was essentially a man of the *ancien régime*, a diplomatist of the eighteenth century, cynical, non-national, finessing, living in a selfish world of high aristocrats, oblivious of patriotism, nationality, democracy, and measuring all statecraft by the rule of *raison d'état*; such is the "psychological basis" of the "Memoirs."

The motives which run through the "Memoirs" appear to be: first, to show and to defend the political sagacity of Bülow. Second, to indulge in a bitter, ironic and highly diverting humour, at the expense of society in general, and especially at the expense of great reputations. Third, to throw into a bright light the vagaries and absurdities of the Kaiser, Bülow's master, while professing always as a loyal friend to shield and excuse him. And fourthly, to pillory on every possible occasion a useful if not highly distinguished public servant, Count Monts, who finished his active career as German Ambassador at Rome; in the same way a great object of the later volumes seems to be to expose to the scorn of posterity the ineptitude, as Bülow conceived it, of his successor, the Chancellor von Bethmann-Hollweg.

Bülow and Monts were contemporaries, and had started official life in much the same way, by passing the State legal examinations and entering the diplomatic service. Bülow was brilliant and forged ahead. Monts was his devoted follower and picked up gratefully the crumbs of patronage which Bülow procured for him. Monts' letters, which Bülow quotes at great length, are effusive, flattering. Bülow professes to have despised the flattery. When he became Chancellor he made Monts Ambassador at Rome. Thereafter some coolness intervened; and from beginning to end of the second and third volumes of the "Memoirs," nothing good is said of Monts. The result is that the name of Monts, which might otherwise be forgotten, will be preserved as long as these memoirs are read, and owing to its frequent mention there, and the many letters which are quoted, will be almost as celebrated as Bülow's.

Bulow's "Deadly Shafts."

Yet, though a large part of a volume of the "Memoirs" (Vol. II) might almost be called an "Anti-Monts," it is the letters of this very Monts which are used by Bülow for sending forth some of his deadliest shafts. Monts describes the Imperial

**Memoirs*, vol. i., p. 242.

Court and the Kaiser : " His Majesty thinks that he, and he alone, conducts policy." And again (from another of Monts' letters) : " My one hope now is in the Emperor himself. If only he would get a glimpse of the truth, realize the position he is in and see to what he had brought his fatherland. If he were surrounded with decent people, the psychological moment would, given H.M.'s high intelligence and his many calm and lucid intervals, have arrived long ago. The chasing from place to place, from banquet to banquet, the intercourse with Tom, Dick and Harry, leave no time for self-examination. None the less my conviction is that a year of peaceful life in the country, with only the necessary functions and duties, would restore his mental balance."

It is a letter of Monts which preserves the bitter gibe of Count Eugene Kinkey on Austrian statecraft. Being once asked what the Vienna Government would do in a certain eventuality, he replied : " How do I know what's the stupidest thing to do ? "

Monts, however, is not the only friend who is used as a vehicle for spite. Philip von Eulenburg, who was also the Kaiser's intimate friend and counsellor, is quoted as giving Bülow advice : " Only if you take the Kaiser the right way psychologically, can you be of use to your country. . . . He is as grateful for praise as a good and clever child." The Kaiser himself is utilized to express Bülow's spite, as it were, by a side-wind, concerning yet another great reputation. Prince Chlodwig Hohenlohe, Chancellor until Bülow succeeded him in 1901, was the man whom he calls " the noble Hohenlohe," " that great nobleman," a statesman with " knightly perspective " ; but the Kaiser expressed himself " very unceremoniously about Uncle Chlodwig," whom he called " the old Imperial idiot."

Later, on his own account Bülow, in his best finessing style, tells a slightly improper anecdote about Hohenlohe, in order to shatter the legend of the upright nobleman, the *grand seigneur* who despised comfort and who, when ordered by the doctor to repose on account of his heart, " insisted on carrying out the reclining treatment on three hard cane chairs " ; Bülow relates this as a fact. Finally, he sentimentally describes his last sight of the prince and princess whose guest he was at the Hohenlohe ancestral home, Schillingfürst, standing, a frail old couple, in front of the family mausoleum " which was so soon to receive them both."

Prince Hohenlohe, however, though on the brink of the grave, is not to be let off without doing service against Bülow's friend and master. Twice Hohenlohe is reported as gravely asking Bülow whether he thinks the Kaiser mad ; and Bülow in reply gave reasons for holding that the Kaiser was not mad or not quite. Bülow has also a good many ill-natured things to say, while professing to explain matters charitably, about the Empress Frederick, and her Imperial son's relations towards her. The Kaiser is said to have at first adopted an anti-Greek attitude (in 1897) because he wanted to annoy his phil-Hellene mother " whom fundamentally he admired for her wit, her culture and also for the obstinacy of her character." The Kaiser, according to Bülow, sometimes loved his mother—" he certainly loved her more than she loved him." Naturally, Bülow puts on record a remark of the Empress Frederick to his mother-in-law : " Remember, Donna Laura, what I say to you to-day : my son will be the ruin of Germany."

THE KAISER IN ENGLAND, 1907.
With King Edward and the Duke of Connaught at Windsor.

Then, as indicative of the man-in-the-street's opinion of the Kaiser, Bülow narrates the " Brandenburger Thor " story : " All Berlin laughed over the story of how, in the Friedrichstrasse, a Hungarian who, like many of his countrymen, used to mix up his articles, went to a policeman and meaning to say : ' Where is the Brandenburg Gate ? ' (*Wo ist das Brandenburger Tor ?*) actually asked : ' Where is the Brandenburg fool ? ' (*Wo ist der Brandenburger Tor ?*) to which the honest policeman angrily replied : ' If you

make fun of His Majesty again, I'll run you in.' "

Domestic scandal, deftly introduced, is one of Bülow's *fortes*, while himself maintaining an attitude of superiority and indifference. At the end of one of his indelicate reminiscences, he will write, with feigned and ironical sanctimoniousness: "I have never found anything more futile than this sort of research into paternity. Not only because such nosing about is thoroughly disgusting, but because, whatever our parentage, we are all equal in the sight of God, all poor mortals, with human imperfections and weaknesses." He immediately follows this remark with what he calls "a lovely story" (*eine hübsche Äusserung*) which he says the Kaiser told him about his (the Kaiser's) aunt, the Princess Henrietta of Schleswig-Holstein-Sonderburg-Augustenburg.

BÜLOW AND HIS SUCCESSOR, 1909.
With Bethmann-Hollweg in Berlin, before Bülow's departure.

This extraordinary man, Secretary of State and Chancellor of the greatest Empire in Europe, had a profound contempt for his own people. He writes: "The gods who gave our people so many productive, great and noble qualities, denied them political sense. Once when I was leaving a Reichstag session I made this complaint to Minister-Director Althoff, and that distinguished man answered with his own peculiar Westphalian wit: 'Now, now! What are you complaining about? We Germans are the most scholarly nation and also the nation most fitted for war in the world. In all the sciences and all the arts we have done wonders; the greatest philosophers, the greatest poets, the greatest musicians, are Germans. Of late in the natural sciences and in practically every technical domain we stand in the front rank and have accomplished a prodigious economic development. How can you be surprised that, politically, we are asses (*dass wir politisch Esel sind*)?'"

In a similar vein, Bülow writes that in the early years of the German Empire, the nations of Europe had not learned to hate Germany. Therefore Bismarck, "with his unique inventive genius," extracted considerable advantages from the disagreements of other Powers with each other. This, however, could not go on in the days of Germany's greatness, when she was the envied of Europe. "I pointed out in the Reichstag that we could not live on the enmity between other Powers. In conversations *tête-à-tête* with more than one German politician or publicist, I demonstrated that the surest way to prevent disharmony between other Powers was to betray a longing on our part to see it, and to make too naïve an exhibition of the satisfaction of the *tertius gaudens*. But the sons of Teut are by nature unpolitical. They are guided in their activities mainly by their emotions, seldom by cool reflection, and they fell again and again into this error."

If the Germans had one political fault more than another, it was the quality of always going to extremes. "The especial gift denied to us in the domain of politics, it seems to me, is moderation." Bülow does not fail to point out minor defects, especially that of the Kaiser's *entourage* whose motto seemed to be: "Tactlessness is manliness." So much for Bülow's opinion of his own people; but he did not think much more highly of mankind in general, and quotes, with apparent approval, a remark of Bismarck to him, "that there were many good and some clever folk, but only a few who were both good and clever."

Curiously, Bülow, so cynical in judgment on his own people, is singularly sympathetic and admiring in his appreciation of the English character, and of English society which the Kaiser particularly enjoyed. In 1898, on the way back from his Syrian tour, the Kaiser, steaming in his yacht to Malta, was telling Bülow and the rest of his staff at table how he was going to speak plainly to the British naval officers "without mincing his words." Nevertheless, writes Bülow, "history only repeated itself at Malta. As usually happened when he came into personal contact with Englishmen, the Kaiser once more succumbed

to the charm he had always felt since his youth in the presence of a well-bred English gentleman, with his quiet manners, his self-possession, and his independence, combined with the utmost courtesy.

"Admiral von Senden, whose fundamental Anglophobia came to the surface more and more the nearer we drew to Malta, said to me as we entered the Grand Harbour, with a note of triumph in his voice, for he knew how concerned I was to maintain cordial relations with Great Britain: 'Now you will see the Kaiser tick those English off. He'll begin on the Admiral!' But when, half an hour later, I was pacing the upper deck with Senden, he suddenly pointed angrily to the bridge. There stood the Kaiser, arm-in-arm with the British Admiral, who had come on board only a few minutes before to pay his respects, and he was treating him with every sign of cordial, comradely friendship."

In November, 1899, the Kaiser and Kaiserin with Bülow in attendance visited England. This was in the middle of the Boer War. The German Ambassador at London, Count Paul Hatzfeld, wrote to Bülow asking him to try and induce the Emperor's staff not to be "touchy." "Over here both the Queen and her Court intend to show the greatest kindness to their German guests. The only thing to bear in mind is that social ways over here are much freer than ours are and very different. Much less attention is paid, therefore, to the individual rank of any particular person, and a colonel or general is treated no differently from a lieutenant, if one wishes to be on friendly terms with either. This is the custom of the country and not the slightest harm is intended."

German Stiffness.

Bülow, as a genuine aristocrat, could admire this kind of thing, and laugh at German stiffness. He had a fellow-feeling for the English nobility, and records a conversation with the old Duke of Cambridge about them and the South African War. "He said very finely to me: 'The war in South Africa is not going too well at present, and its origin and the political side of it are very open to question. But it is giving the British nobility the opportunity of showing that they still know how to die.'" Bülow's conclusion from a study of British politics was that "there is no more democratic aristocracy than the British, and no more aristocratic democracy."

At the end of the visit to Windsor in 1899, Bülow drafted a memorandum on Great Britain, confidential of course, and for use of Prince Hohenlohe and the Imperial Foreign Office. This memorandum has been more than once published. Parts are reproduced in these posthumous memoirs, so it would seem that Bülow was sincere in what he thus wrote, and meant to hold by it through eternity. He rightly considered that British politicians and statesmen knew far too little about the Continent—about as little as German politicians knew of Peru or Siam :—

And British Naivety.

"They are also, according to our ideas, rather naïve in their artless egoism, as well as in a certain blind confidence. They find difficulty in believing in really evil intentions in others, they are very calm, very phlegmatic, very optimistic. The South African War excites the people of Berlin more than it does London political circles. No one doubts that Britain will emerge well from the affair. The country exhales wealth, comfort, content, and confidence in its own power and future. It is clear that the people have never seen an enemy in their country and simply cannot believe that things could ever go really wrong either at home or abroad. With the exception of a few leading men, they work little and leave themselves time for everything. It is physically and morally a very sound country. In general there is no question that the feeling in Britain is much less anti-German than the feeling in Germany is anti-British."

Bülow reinforces this judgment by repeating in his "Memoirs" in, as it were, an aside: "If I may express a general judgment, which perhaps has no other advantage than that of being based entirely on direct impressions, I would say that the physical, intellectual, and moral soundness of all classes struck me as the characteristic of British conditions and of British ways. Britain appeared to me a thoroughly sound country and nation. I found everything in England sound, from the English care of infants which is incomparable, and the English nursery which is the best in the world, to the grown-up Englishman, toughened by continuous bodily exercise, even in quite advanced years. With no more than such well-nourished strong bodies, and such a strong national feeling, something can be achieved. The English are in truth a nation of Sahibs."

As an instance of this knightly character of the English, he contrasts the jeers that greeted Bismarck's son, Herbert, on making his maiden speech in the Reichstag, with the courteous and generous welcome given by Mr. Gladstone in the House of Commons to the first speech of Austen Chamberlain, the son of the statesman from whom Gladstone was separated by a deep political and personal difference.

The years 1897-1909 covered by the second volume of the "Memoirs," when Bülow was at the German

Foreign Office first as Minister for Foreign Affairs and later as Chancellor, are perhaps the most momentous years of all in the history of Anglo-German relations. It was during this period that the Tirpitz naval policy was adopted and established, and it was then also that the proposal was made and actively canvassed in both countries for an Anglo-German alliance, which, if it had come to pass, would have solved the enigma of Anglo-German relations.

A Dangerous Period.

Bülow's view over these eventful years is that they were a dangerous period which, however, under reasonably skilful direction Germany could pass through without war and without making war likely to come in the near future. "My mind was clear on one point long before my summons to Kiel: that Germany had little to gain by a war and a great deal to lose." On the other hand, "every year during which we kept peace with honour was a gain to us. Our population and our economic strength grew each year. Time was on our side, especially when we made comparison with our most dangerous neighbour, France." Time for what?

It almost seems that Bülow looked forward to a period when Germany, having passed through the intermediate years without the cost of a war, would be so rich, prosperous and powerful as to be dominant in Europe. Meanwhile, a great fleet was to be constructed, and Bülow set himself to see that this should be done without provoking England. He was the pilot who was to take the German fleet through the danger-zone, the years when the fleet was being constructed and increased, until it should reach the dimensions of grandeur.

Perhaps the chief difficulty, as far as naval policy went, was in making the Kaiser do his duty. He loved the fleet so, and would often talk about it not as a serious subject, but as a splendid plaything which nobody should deny to him. In 1904 King Edward VII visited his Imperial nephew at Kiel when the regatta was in progress. The Kaiser made a speech in praise of yachting, King Edward, the Royal Yacht Squadron, and English ships which aroused his enthusiastic admiration. Then he became reminiscent. King Edward replied in German with a brief, gently ironical, but good-natured and tactful speech.

Bülow had no doubt that he could secure a passage for the Fleet Laws through the Reichstag, even if he had to play a little dangerously upon the chords of nationalist sentiment and excitement. "What I was more doubtful of was whether England would give us the chance and the time to carry out these extensive and far-reaching plans of Admiral Tirpitz." Bülow, therefore, as the highest responsible statesman in Germany, had the double task of seeing that the Grand Fleet should be constructed (a matter of years) while keeping England quiet. Perhaps this is the real explanation of that long and curious alliance-negotiation in which Bülow engaged (though he did not begin it) with the British Government in 1899-1901. At the commencement of this negotiation he may have thought that some sort of alliance could be arranged, but after a little more experience he seems to have given up this idea.

At the end of the year 1899 Hatzfeld, German Ambassador in London, wrote to Prince Hohenlohe, who was still Chancellor, concerning the alliance-negotiation: "For us it can, so far as I may permit myself an opinion, only be useful if Mr. Chamberlain, *without* us on our part undertaking any obligation, adheres to the hope that we will ultimately allow ourselves to be induced to comply with his wishes as to an alliance or, perhaps, an intimate understanding." A little earlier Count Paul Metternich (afterwards Ambassador at London) had written: "The British are not thinking of attacking us, *i.e.*, our colonies. . . . A European coalition is a sinister bogey to the Englishman. . . . If *we* meantime keep a smiling face, he will the sooner make a small sacrifice for us in order to keep us in a good temper, which is of consequence to him." So the alliance-negotiations probably served their purpose, so far as the Imperial Chancellery had a purpose for them.

Bulow Resigns.

By 1909 the German Fleet was well on the way to grandeur, indeed had already attained it. The danger-zone had been passed safely; Bülow, Chancellor since 1901, had seen England remain quiet, though restive, in face of the growing German Fleet. Now, in 1909, Bülow was really anxious for an agreement, which would stabilize the existing situation. "The question nearest my heart during the whole of my last period in office was the conclusion of an Anglo-German naval understanding." The sands were running out, however. Bülow no longer could control divisions in the Reichstag; he felt that he had lost the confidence of the Kaiser. On 24th June, 1909, he sent in his resignation to the Kaiser. He could always be happy, he wrote in the "Memoirs," with his wife and his books, and especially the Homeric epics to which there are so many apt references, forming one of the numerous charming features of this extraordinary book.

Searching for Rare Birds in East Africa.

By David Bannerman, M.B.E., M.A.
British Museum (Natural History).

A search for rare birds is being made for the first time in the East Usambara mountains, a region ornithologically unexplored. The neighbourhood is rich in bird life and important discoveries have been made.

In *Discovery* last May the writer gave an account of the remarkable forms of bird life which were brought to light by the British Museum expedition to Sierra Leone in 1929-30. Then it was pointed out that it is invariably in the mountain ranges, on isolated peaks or on islands off the mainland which can boast the highest altitude, that the most sensational discoveries in the fauna and flora have been made. The truth of that statement has been exemplified by the exploration—which has yielded most surprising results—of another mountain range in British African territory which lies many thousands of miles from Sierra Leone, on the other side of the continent.

First Results.

Recently Mr. R. E. Moreau (whose name is already known to the readers of this journal through an article which he contributed on the migration of birds in Egypt*) joined the staff of the Agricultural Research Station for East Africa, at Amani. Backed by the authorities of the British Museum of Natural History, he was able to employ a native collector, and commenced a systematic investigation of the bird life of the neighbourhood. It is with the first fruits of his researches that this article mainly deals.

First let me attempt to convey some idea of the physical conditions which combine to make this station so attractive to the naturalist. Amani is situated in Tanganyika Territory on a high spur of the East Usambara mountains, 3,000 feet above sea level. From the research station a strip of coast, thirty-five miles away between Tanga and Pangani, is visible, and the southern end of Pemba Island, distant eighty miles, can also be seen when the atmosphere is clear. The East Usambaras are still heavily forested and of very uniform maximum height, between 3,500 and 4,000 feet in altitude.

Although Amani was for ten years prior to the war the headquarters of the German Biologisch-Landwirtschaftliches Institut, no ornithological work appears to have been carried out. At the beginning of the present century the whole of the Usambara mountains west and east were ornithologically unknown, and only two collections of importance, those of Rochl and Loveridge, have been made. The biology and ecology of this interesting region has been completely neglected and the National Collection, which justly prides itself on its African material, had not received a single specimen from this unique locality. It was therefore with happy anticipation that we learned of Mr. Moreau's transference from Egypt, where he had already done such excellent bird-work, to this isolated corner of the globe.

From the brief description given, and even better from the photographs (reproduced by kind permission of Dr. Nowell) it will easily be realized that the country in the vicinity of the research station is difficult to work. Only a single route, which connects the top of the plateau with the rest of the world, is practicable for wheeled traffic, and that is a tortuous main track which follows chiefly the precipitous Sigi valley. Even native footpaths are limited in number, and owing to the presence of buffalo, many of the old paths have been abandoned. It thus happens that less than three miles from the station as the crow flies there are two extensive ridges of unbroken forest which are both entirely untraversed by tracks and unvisited by human beings, white or black. No wonder that Mr. Moreau saw a chance not to be missed by an ardent naturalist. All the collecting has been done so far in the East Usambaras between the limits of 500 and 3,500 feet above sea level—an area of not much over a hundred square miles at most.

The Rain Forest.

In a general sense the East and West Usambaras may be likened to twin islands separated by a narrow strait; in place of the sea extend miles of dry thorn bush, and as the forest "islands" rise precipitately, the transition from the luxuriant vegetation at the summit to the semi-arid at the foot is extremely abrupt. The highest elevations are clothed with lofty trees below which occurs the densest shade: this is the true rain-forest, and it has a marked influence on the bird population.

**Discovery* March, 1926.

The Amani rain-forest consists of tall, straight trees with uniformly smooth, bare and whitish trunks, supporting an evergreen canopy more than a hundred feet above the ground. The trees are loaded with ferns, club-moss, lichens and other parasitic plant, and hung thickly with lianes. Below the crown of the Amani forests flourishes a growth of smaller trees and shrubs. The ground is rich in ferns, including tree-ferns in the damper places, while in the more open spots the surface is clothed with herbs, and here the only conspicuous ground flower, *Impatiens walleriana*, exhibits masses of lovely red blossom. Wet mists which prevail above 2,500-3,000 feet are doubtless responsible for this luxuriant growth.

These were the conditions which Mr. Moreau found in the East Usambara mountains and the surrounding area when he first turned his attention to the natural history of the district. It was enough for the early naturalists and explorers who were engaged in the pursuit of their own particular quest—whether birds, beasts, insects or plants—to collect and preserve as many specimens as conveniently possible, and on their return home to have their collections identified at a museum. As often as not a specimen was merely labelled with the name of the territory in which it had been obtained without precise locality or other data. For instance, birds that were collected prior to 1870 anywhere between the foothills and the Indian Ocean exist in museums to-day bearing the locality "Usambara," although as we now restrict that name they must have been obtained many miles from the Usambara mountains.

With these early collections it was rare to receive any field notes, and exceptional indeed was the collector who paid any attention to the ecology of the district from which his specimens had been obtained. At the present day all that is changed: the collector has, as likely as not, had a scientific training, and the amassing of specimens is but a means to an end and not, as in the past, the end itself. All manner of fascinating subjects present themselves, and the modern naturalist who finds himself situated at such a spot as that just described sets to work to find answers to the countless problems that surround him.

Mr. Moreau's methods may briefly be recounted as being those of a trained observer finding himself in unusual surroundings. Having a reasonable time at his disposal in which to explore the district thoroughly from a *fixed base*—a very different matter be it noted from that which confronts the naturalist on trek—attention was first centred on the types of vegetation prevailing, as being most likely to have a bearing on the fauna. Five natural and five artificial associations were found to occur. In the first category may be enumerated: heavy rain-forest, light rain-forest, dry forest, mountain grassland, swamp; and in the second category: coffee plantations, Amani plantations, native cultivation, rubber plantations, planted grassland.

MOREAU'S LONGBILLED WARBLER.

For this bird a new genus will have to be proposed. It has an unusually long bill and a graduated tail. The drawing is by Mr. H. Grönvold.

Each of these was in turn subjected to close examination. The three types of forest were examined from the point of view of their predominating constituents, their tree and plant associations noted, as well as their altitude, density as regards light, humidity, amount of precipitation, and so on. In particular it was important to discover the connexion, if any, between the forests of the Usambara mountains and other distant mountain masses which might support a similar flora and fauna, so that if possible a comparison might be made. What influence, if any, has Kilimanjaro had on the Usambaras? Questions such as this can only be answered when a census of all living things on these mountains has been completed.

As with the forests, so with the mountain grasslands and the swamps. These all have a marked bearing

on the animal and bird life and, being of ancient and natural origin, are more likely to indicate the affinities of the local fauna than are those of recent artificial origin such as the various plantations enumerated under the second category.

Every one of the ten " associations " is inhabited by its own peculiar, or at any rate dominant, species of birds. Thus, among the many birds confined mainly if not absolutely to the rain-forest, the silvery-cheeked hornbill, red-eye crimson-wing, a swamp warbler, the white-tailed crested flycatcher, the yellow-throated flycatcher-warbler, the sokoke akalat, a bush-shrike and Roehl's olive thrush may be cited as truly representative. Characteristic of the light rain-forest are the little yellow flycatcher and the East African crested flycatcher. The third type of forest, which is termed the dry forest, resultant from extreme poverty of soil and exposed position rather than rainfall, is definitely poor in birds, the drongo being perhaps the most noticeable.

AMANI FROM THE WEST.

It was from the Agricultural Research Station, seen in the photograph, that Mr. Moreau conducted a systematic investigation of the bird life. (E.A.A.R.S. photo.)

On the mountain grassland, which occupies the tops of certain ridges and is intersected here and there by gallery forests, the bird life is also poor, and this may be explained by the fact that the dominant grasses do not produce edible seeds or at any rate seeds that are much sought after. Characteristic of this restricted area is the Kilimanjaro stonechat and also a tiny grass-warbler which bears as its subspecific name that of the distinguished German ornithologist, Professor Anton Reichenow.

Among typical swamp and marsh frequenting birds may be mentioned the widely distributed black rail and the grosbeak-weaver. The former, although its range embraces practically the whole of Africa south of the Sahara, shows no variation throughout its distribution, whereas the latter, with much the same range, has become differentiated to such an extent that no less than eight well established races are recognizable, varying in shade of plumage, size of bill or length of wing. Why the grosbeak-weaver should be so influenced by environment while the rail has remained unaffected affords a little problem in itself very difficult to answer. Fortunately for the writer it lies outside the scope of this article !

As invariably occurs when a virgin country is " cleared," the fauna undergoes a swift change ; trees and shrubs not hitherto indigenous attract species which formerly never occurred in the neighbourhood ; and this is what has taken place in the restricted area under discussion. In the recent clearings, whatever their composition—coffee, rubber, etc.—certain features are common to all. Grasses, for instance, attract many small finches; a blackberry-like shrub tempts fruit-eating species ; the seeds of the horrible weed " Black Jack " are eaten by a serin-finch ; the leaves of a palm-like tree afford nesting sites for the little grey palm-swift, and another introduced plant is greatly appreciated by sunbirds of more than one variety. It can easily be imagined how these examples may be multiplied especially in the vicinity of the Amani plantations, where various experiments are continually being made with introduced plants and trees.

The coffee-shambas are much frequented by a bunting which nests in the heads of the coffee bushes, and although no bird appears to touch the coffee flowers or fruit, various other species, such as the serin, geelgat, Roehl's flycatcher and several of the weaver birds, may usually be encountered in the plantation.

In contrast to the comparative abundance of birds on ground where coffee is cultivated, the exact reverse obtains on a rubber plantation. This is poor ground from both the botanical and avifaunal standpoints. The half dead looking grey stems of the rubber form a dense mass, a shade plant grows rankly and below is a mat of *Panicum* to the exclusion of everything else. The only bird that shows any appreciation of such gloomy surroundings is the crested guineafowl (*Guttera pucherani*). To the small area of planted grassland (a fodder grass introduced from South

America) such birds as the meadow pipit and yellow wagtail resort during the months when they are wintering in Tanganyika.

Then we have the native cultivated land, where among the crops of maize, cassava, sweet potato, beans and bananas, only the first named is an attraction to birds, several local weavers preying upon the grain. When this cultivated land is abandoned the scrubby and rank vegetation which rapidly gains a hold attracts such birds as the Prinias and grass-warblers, several species of which appear quickly on the scene.

Finally the Amani plantations themselves have a considerable influence on the bird inhabitants, for thirty years' growth of exotic plants has greatly changed the aspect of the land for the feathered population. Instead of dense tropical rain-forest such as already described there exists a unique collection of plants of economic importance assembled from all over the tropics, and varying from Kilimanjaro giant heather, oil palms and bamboos to cinnamon trees, guavas and tea bushes. These trees bear fruits which are eagerly consumed by hornbills, white-eared barbets, geelgats and others, while nesting sites and nesting material are provided in quantities by many more. All manner of birds which might otherwise never be seen, such as sunbirds, white-eyes, colies, turacos, various doves and barbets, therefore throng to the Amani plantations. The discovery here of a wonderful new weaver bird at the edge of the forest, black above, yellow below, unlike anything which has been seen before, is proof that the Amani plantations hold some very remarkable species.

THE INDIAN OCEAN FROM AMANI.

The difficulty of exploring the surrounding country is well illustrated in this photograph by R. R. Worsley. The Indian Ocean can be seen in the distance.

One could instance all manner of ways in which man and his works can change the whole aspect of a bird population. Even telegraph-wires play their part, affording an unrivalled perch from which drongos, geelgats, shrikes and swallows can get their living. The artificial banking of roads will often attract bank-burrowing birds to a district; the arrival of cattle in a country invariably brings in its wake such birds as tick-birds, cattle egrets, and the like. But enough has been written to show how important is environment on the bird population and how drastic can be the changes made by human agency in the fauna of a small area, once virgin forest.

The statement has been made earlier in this article that it is to the primeval forests that we must turn when attempting to trace the origin and affinities of the avifauna, and it is in the rain-forest of the East Usambara mountains that Mr. Moreau's most striking discoveries have been made. Probably the most interesting of his novelties is a tiny warbler with dull coloured grey and buff plumage but with an extraordinary long bill and graduated tail of eight feathers. This little bird, when more specimens are obtained, is almost certain to require an entirely new genus in the scheme of classification. It already bears the specific name *moreaui* in honour of its discoverer. It was obtained in the forest at 3,000 feet close to Amani. Its nearest ally was at first thought to inhabit the highlands between Lakes Nyasa and Tanganyika, but I am doubtful whether it will be found to have any near relation at all which is known to science.

Another inhabitant of the Amani forest which has proved to be new is a white-eyed flycatcher, silvery-grey in colour, the only relative of which was described from Mount Kilimanjaro. Races of species already well known are constantly being discovered in Africa but special interest always attaches to the discovery of the first race (or subspecies) of a bird which has long been thought to be unique. Such then is this new flycatcher which Mr. Moreau has sent home to the British Museum. It has been given the name *Dioptrornis fischeri amani* by Mr. W. L. Sclater.

Space does not permit me to enumerate all the novelties which these forests hold, but mention must be made of a wonderful new black-breasted bush-shrike. The back, tail and wings are olive green, and it has a grey cap and mantle, black cheeks, breast and throat, and dull olive yellow belly—altogether

a very beautiful bird and an entirely new species. It is confined to the heavy rain-forest—which is certain to hold many more treasures buried in its depths. This new shrike has been christened *Chlorophoneus nigrescens*.

In the same forest and side by side with the species just described lives the black-fronted bush-shrike (*C. nigrifrons*). It is a curious point that viewed from above both this and the new shrike are so similarly coloured that it is impossible to tell one from the other: only when a glimpse is caught of the brilliant yellow underparts of *C. nigrifrons* is it seen to be quite a different shrike. Their notes too are identical.

A New Race.

Then again a fine apparently new francolin has been found to inhabit the depths of the forest. This bird is almost certainly representative of a new race, but as it has only recently arrived at the British Museum it is too early yet to pronounce upon it.

Of special interest is a tiny swamp-warbler, of the genus *Bradypterus*, which is not only confined to the Usambaras but is a remarkable example of restricted habitat, for it seems to pass its entire life within six feet of the ground. This, too, has proved to be a new race.

Of other birds which are known as yet only from the Usambaras, mention may be made of the green-headed oriole, the spot-throat thrush-babbler, a forest-warbler and a blue-billed weaver. To reel off a long list of the other rare forest inhabitants would only bore the reader, and enough has been said to prove how rich in new forms is this forest-clad mountain mass. Of the larger animals there exist a few leopards, red duiker, many colobus and other monkeys, squirrels, flying squirrels and hyraxes. The presence of the colobus monkey is in itself significant, for the colobus is a species which must have been isolated on the East Usambaras for a vast period, since it is quite incapable (owing to its restricted vegetable diet) of wandering over the wide tracts of dry thorn bush (which now virtually surround the Usambaras) in order to gain access to the forests in which it at present lives.

In studying the distribution of these East Usambara birds, two points stand out: firstly, the great number of endemic forms, almost comparable in number to those of an island like Fernando Po; and secondly, the fact that here many of these mountain forms are found living at a much lower altitude than are their nearest allies in other mountain forests of Africa. It is early yet to write of the affinities and origin of the Usambara fauna, since this article deals only with the first fruits of Mr. Moreau's investigations, and the present writer is confident that before long much data bearing on the subject will be brought to light, especially when attention is turned to the small mammals.

The presence of the Pare mountains, which form a partial bridge between Kilimanjaro and Usambara, suggests a possible source by which the fauna may have reached this now isolated mountainous country; but notwithstanding the wide gap that separates them, the Uluguru mountains, some 160 statute miles to the south, would seem to have most in common with the Usambaras, a considerable number of the birds being peculiar to both and as yet found nowhere else. The connexion which exists between the mountain faunas of Africa is one of extraordinary interest and is now receiving more attention from naturalists. It can hardly be explained other than by the changes in climate which have taken place since Pliocene days.

That a great part of Africa was then covered with forest seems to be generally accepted. With the march of time and change of climate these forests have become more and more restricted, until at the present day there remains but a remnant of their glorious past in the shape of isolated areas, some small, some large, but all separated from one another by tracts of land, which owing to continued dessication are now given up to thorn scrub, such as that surrounding the Usambaras. The fauna which in past ages throve in the highest altitudes has become as completely isolated as if these mountains were islands surrounded by water. Intercourse having ceased, each community has come under slightly different conditions tending to produce stable but divergent races which we call subspecies. The birds discovered on the Usambara range by Mr. Moreau afford yet another striking example of this discontinuous distribution.

Preservation of Fauna.

THE excellent work of the Society for the Preservation of Fauna in the Empire is likely to suffer by the necessity throughout the world for measures of economy. As Sir Peter Chalmers Mitchell pointed out at the annual meeting, the need for cutting down expenditure has given a very good opening to those who are opposed to game preservation. Fortunately one of the most important measures will not cost any money at all. The transforming of reserves into national parks in various parts of the world would do much to safeguard the fauna and would not call for additional expenditure. At present, reserves depend upon the goodwill of individual governments and are liable to be opened up for other purposes.

Biology and Civilization.

By H. H. Dale, F.R.S.

In a recent lecture Dr. Dale urged the need for a wider popular interest in biology. A real danger to civilization is foreseen in the concentration of public attention on physics and astronomy to the comparative neglect of biology. There can be no progress in human society which is not guided by biological knowledge.*

I THINK I am right in believing that the possibility of a connexion between biological knowledge and aviation came as a surprise to some who were concerned, in the early years of the war, in organizing the new use of airplanes as fighting machines. The fact that the low tensions of oxygen at high altitudes would affect not only the engine but the airman could, of course, have been predicted by mountaineers; and the symptons had long been studied and analysed by physiologists.

Blood and Breathing.

When these were asked for advice, and sought permission to take small samples of blood for investigation, it was firmly explained to them, by authority, that the trouble was with the airman's breathing; and what, it was asked, had blood to do with breathing? Not an easy question to answer, perhaps, with polite brevity, in view of the fact that one of the major contributions to science, of British physiologists in particular, from John Mayow in the seventeenth century to Haldane and Barcroft in our own times, has been to demonstrate and to describe exactly what blood has to do with breathing, and how it does it.

Many curious things happened in those days, and we have no need to be too critical of what occurred at a time of hurried improvisation and forced development. The new Air Force soon learned that efficient flying involved many problems in physiology, and gave it a proper place in its research organization. The speeds recorded in the winning of the Schneider trophy, and the subsequent attainment of a new maximum velocity in straight flight, have awakened a general interest in the limit of possible rapidity in human transport.† These record flights, however, have not only given knowledge to engineers concerned in the design of airplanes and their motors; they have also brought into new prominence the fact that the reactions of the human organism to the stresses occasioned by these colossal speeds will play an important part in any further developments, and may well prove to be the limiting factor.

This sequence of events, in the short and crowded history of aviation, suggests analogies with those of a longer history, covering a much wider field. It is a commonplace that physical science and mechanical invention have probably made greater changes in the conditions of civilized human existence during the past 150 years, than in the preceding twenty centuries.

A man of science can have no sympathy with those who look at our modern civilization with a vague and vain regret for the idealized simplicity of the pre-scientific era. His desire is to see real scientific knowledge and method become, not less, but much more effective in thought and practice in every department of human activity. My purpose is to advocate, not an unscientific but a balanced and biological outlook on human progress—a habit of mind, which, while proudly recognizing the command over inanimate nature, and still more the wide intellectual range which physical and chemical science have given to man, keeps clearly in view the fact that there can be no permanent progress of human society, no real advance of the human race as a whole to a higher level of physical and mental efficiency, which is not guided by the growth of biological knowledge and the recognition of biological truth.

Progress of Civilization.

Just as the speed of the airplane may find itself limited by the possibility of biological adjustment, the speed of our mechanized civilisation may, in the long run, become merely detrimental to real human progress, unless biological knowledge keeps pace with it, and ensures that it does not divert attention from the central aim of racial improvement. It is, I suggest, worth while to consider whether the imposing achievements of physical science have not already, in the thoughts and interests of men at large, in our educational and public policy, as well as in technical and industrial development, overshadowed those of biology to an extent which threatens a one-sided

*Norman Lockyer lecture of the British Science Guild.

†" Travelling as Fast as Sound ? " By J. L. Nayler. *Discovery*, November, 1931.

development of science itself, and of the civilization which we hope to see based on science.

Looking beyond man's immediate physiological requirements, but still at the material needs of civilization, the biological problems which wait for solution are overwhelming in their extent and variety. We can only glance and select. I find it cheering to see systematic, descriptive and ecological zoology and botany, too long inadequately appreciated even in some scientific circles in comparison with the experimental sciences, achieving new recognition of their practical worth and cultural value. In the tropics in particular, more and more exact systematic biology is needed to enable man to recognize and to use his friends, and to fight his enemies, whether plant or animal. We are only beginning to realize the dimensions of such problems as those presented by the tse-tse flies, carriers of fell disease to man and his cattle, by the locusts which annihilate the fruits of his labour, and by the hosts of external and internal parasites which prey upon the higher animals and plants.

There are problems here enough to use all the genius for fundamental research and practical invention, all the enterprise and fighting spirit, which the world can spare from other interests, for any period in the future which we can foresee. Perhaps a day may come when some part of the vast expenditure, not only of material wealth but of scientific ability, which the most highly developed peoples still dedicate to the means of destroying their fellow men, will become available for war on these common enemies of mankind, and of the plants and animals by which men live.

Co-operation of Physics.

There are points at which functional biology, in its attempts to analyse and to apply exact measurements to the minute and evanescent phenomena of life, in the cell units of organisms which it can see and handle, finds itself already halting for want of physical methods of the required delicacy and precision. Physical science has found methods for counting electrons, for reading the plan and the spacing of nucleus and satellite electrons in the atom, of atoms in molecules and molecules in crystals. When biology finds itself dealing with structures approaching molecular dimensions, the onlooker might expect to find physics eager to join hands with it in fashioning the methods and guiding the quest. There is little sign, as yet, that such a partnership will become really effective; and the lack of it, I think, is intimately connected, both as cause and effect, with the tendency, which I have suggested, to a one-sided development of our thought and our civilization. Among men of science, as in the world at large, the triumphs of physical science in dealing with inanimate nature seem for the time to have attracted even more than their proper share of the available intellectual interest.

Specialization.

The causes are not simple. We need not look far back into history to find a time when the whole body of the scientific knowledge then achieved was within the compass of a good intelligence. If you look into the early history of the Royal Society you will find some of the great men of those days being led by their free scientific curiosity into fields of investigation much wider than those which we usually associate with their names. We do not now expect astronomers and architects, for example, to take a direct part in experimental physiology and medicine. It comes to us as a surprise to find a record of Christopher Wren discovering and demonstrating the procedures of intravenous injection and blood transfusion, by use of what we should now call a hypodermic syringe, devised and made for him by Robert Boyle.

When with the later expansion of scientific knowledge and activity some specialization became inevitable, the primary and natural division, now effective in most national academies, was between the mathematical, physical and chemical sciences on the one hand, trying by different methods to explore the fundamental nature of the material universe, and the biological sciences on the other hand, for a long time largely occupied with a more superficial description and classification of living things. It could hardly be otherwise. For biological study nature presented forms in enormous number and variety, increasing at a bewildering rate as new countries in the most prolific parts of the world were opened to exploration. To describe, even sufficiently for identification, to classify, and to study the life history, the habits and the distribution of the species belonging to one natural order in one country, might occupy the life-time of a trained investigator.

This systematic work is beginning to take its proper place as a factor in civilization. In time the cleavage deepened between the main divisions into which the sciences had been grouped for convenience; and many of those occupied in either field preserved not much more than a layman's interest in what was being done in the other. To those working in the physical field it would probably seem obvious, and to a large extent was true, that their work had a more fundamental character, brought into play a more advanced machinery of thought, and demanded a higher capacity

for concentrated mental effort. In general, however, the two main divisions of scientific activity acquired an increasing aloofness from one another; and it is only natural, as an aspect of the general tendency which we are discussing, that the aloofness from biology of those engaged in the mathematical and physical sciences should, with few exceptions, have become the more complete in recent years.

New Contacts.

Biology on its part has at various points been making new contacts with and finding new needs for the methods of chemistry and physics. It has still before it a large part of its descriptive task; but it has passed from the stage at which its activities were predominantly observational and systematic. However true it may once have been that the work of biology made a smaller demand on intellectual effort, the suggestion is rapidly losing validity. From different sides biology has been moving forward in its more fundamental task of analysing the phenomena of vital activity—motor activity of protoplasm and muscles, secretory activity of glands, nervous activity of nerve cells and fibres—with the aid of the resources, whether of methods, instruments or theory, that physics and chemistry have provided.

An ultimate aim of experimental biology must be to state those phenomena of life which it can measure and analyse in terms of physics and chemistry. In that sense physics and chemistry can claim to represent the more fundamental aspect of experimental science. Biology may pretend to the more fundamental aim, as it approaches its task of analysing the physiological events in the brain which, in some manner still far beyond our apprehension, and perhaps for ever so, form the essential material background for the percipient and analytical activities of the mind—even for those which give us the highest flights of chemical, physical or mathematical theory.

We may leave the adjudication of such rival claims to speculative philosophy. Our concern is with the two great bodies of experimental science; and we have no need to claim for either that it makes the higher natural appeal to our sense of wonder and beauty, or that it can offer the greater opportunity to the highest powers of the mind. Let each man decide for himself according to the quality, as well as the quantity, of his mental endowment; but let us see to it that our educational system gives him the opportunity of a free choice.

The influence of any movement in science on the general trend of our civilization will probably be determined, less by the reactions to it of professional men of science, than by those of ordinary thinking men. Public appreciation of the importance of particular items of scientific discovery or advance is notoriously capricious, and often determined by some irrelevant accident. We may observe certain general tendencies, however, which have a clearer and deeper significance. Biology took a high place in the general interest in the middle years of the last century, when Darwin had made his great synthesis of biological data into a coherent theory of evolution—an event which has probably produced a greater change in man's attitude to nature than any other since Newton. Even in this case, however, the effect of a great scientific conception on the general mind was aided by special circumstances; directly by the expository genius of Thomas Huxley and indirectly by the shortsighted attempt of religious dogma to restrict the freedom of science in its own proper sphere.

In more recent years public appreciation has swung notably to the other side. There have been many reasons why it should do so. Since the opening of the new century physical and mathematical science have been carried forward on one of the major waves of scientific advance. They have found a public, still very ignorant no doubt, but prepared beyond all comparison with the average men of an earlier generation to be persuaded that they can understand what is happening, and genuinely desiring enlightenment. The teaching of science in the schools is probably beginning to show its effect; but the educational influence, in later life, of daily and familiar contact with the apparatus of modern civilization, with the physical problems of the motor-car and the wireless receiver, has probably been much more potent. Again, we may gratefully recognize, as another important factor, that some of the foremost direct contributors, in our own country and time, to the recent advances in physics, mathematics and astronomy, are masters of a noble English prose, and have used it for such vivid and clear exposition that the ordinary man has obtained at least a feeling of intelligent contact, even with conceptions which are beyond the real grasp of all but a few of those who follow science as a profession.

Popular Interest.

It is no small achievement to have awakened popular enthusiasm for ideas which have a real meaning only for the advanced mathematician. Theories of relativity, and mathematical conceptions of cosmic evolution and atomic structure have found a place, sometimes in strange company, in the pages of a popular Press. Such evidence of a widespread desire

to know something of these furthest reaches of scientific thought towards a conception of the nature of the universe, must surely, in itself, be a cause of rejoicing. But, while we may welcome any sign of the awakening of general interest in the achievements of science, an unequal concentration of this interest on the physical, to the comparative neglect of the biological aspect, reflected in our educational and administrative systems, may become a real danger to our civilization. I believe that this danger exists.

Science in the Schools.

Consider our educational system, and the beginning of this inequality in the secondary schools. Science, I suppose, has so far won its long battle for recognition in the schools as a cultural factor, that the majority now offer an opportunity to all their students for acquiring some knowledge of mathematics, physics and chemistry. Biology, on the other hand, where any provision at all is made for its teaching, is hardly ever a part of a normal curriculum. An intelligent appreciation of the fundamental facts of biology is not yet regarded as a necessary part of the equipment of an educated man. On the contrary, it is seldom that any serious teaching in biological subjects is provided in the school for any except those who need it least, from the point of view of a balanced education.

The present need is great ; but the greatest problem of all lies in the future. The young but brilliantly progressive science of genetics has already brought order and direction to the selective breeding of animal and plant races, fitter for the use of man. It penetrates ever more deeply into the minute cell mechanism, through which competing parental potentialities become effective or hidden in the offspring, or altogether lost. The question becomes insistent, whether man in the future will be able to use such knowledge for the general improvement of his own species, or will continue to reproduce his race under the sole guidance of taboos and traditions which come to him with the force of social, moral and religious laws. Nobody, I think, can suggest that, with our present knowledge, we can predict even the initial stages of a strictly scientific application of genetic principles to the problem of improving the human species. He would be a bold man who would attempt to define either the type or types of human beings which a higher civilization will need, or the policy to be adopted to obtain them. We could, I suppose, form a fairly clear idea of a type of bodily perfection which a genetic policy could accept as its aim. Nobody would desire that any member of our race should be other than well-formed, strong, fertile and resistant to the common infections. In speaking of inherited qualities we cannot, of course, logically separate bodily from mental qualities, due to inherited characters not only of the brain, but of other organs such as the ductless glands.

On the question of mental endowment, I doubt if we could formulate a more definite aim than a higher general level of industry, stability, skill and intelligence. We can hardly imagine a workable civilization composed entirely of mathematical or musical geniuses ; I mention these as examples of what seem to be highly specialized types of inborn ability. For the emergence of such exceptional people it would probably be necessary to depend, as at present, on the chance occurrence of favourable matings, though, if our scheme of social ideals required it, it might be possible to increase the likelihood of their appearance. Even supposing, however, that we could eventually solve this immensely complex problem of the desirable human types, and the desirable proportion of each, we should still have before us the practical problem of applying the principles of genetics for their production.

The duty of science is clear ; it is to continue and to intensify its experimental research into the basic principles of genetics, and to extend the enquiry to the special genetics of the human species wherever data are available. It is a duty, further, so to make clear the nature and the significance of the results of the enquiry as they emerge that all thinking men will, in due course, be able to face this greatest of all human problems calmly, sanely and without prejudice, in the light of a full knowledge and understanding. For this great task biology will need, and must claim, its full share of the highest type of scientific ability that mankind, at its present stage, can produce ; and men in general will need, and must be given, such educational opportunity as will fit them for intelligent appreciation of the facts that science may furnish.

Our Descendants.

It may be that our far descendants, looking back on the imposing technical structure which we are building on the pure science of Faraday and Maxwell, and on all the achievements of our medical science and biology in making life longer and easier, will regard us with amazement as men who could find no greater use for science than to make the best of the world for the human race as we found it. They may look upon what we call our scientific era as a passing phase in human history, before man found the way of using biological knowledge to make his own species capable of a civilization beyond any that we imagine.

Book Reviews.

Universities, American, English, German. By ABRAHAM FLEXNER. (Oxford University Press. 16s.).
Reviewed by SIR FREDERIC KENYON.

Few men are so well qualified as Dr. Flexner to survey the present position of university education in Europe and America, and this volume, in which he considers the universities of the United States, England (not Scotland) and Germany, is a work of capital importance. It is at once a landmark in the history of university development, and a magazine of thought for those who are concerned in the direction of university policy.

Dr. Flexner begins with a brief statement of the ideal of a modern university, with which few will find fault. A university has four "major concerns: the conservation of knowledge and ideas; the interpretation of knowledge and ideas; the search for truth; the training of students who will practise and 'carry on'." It will be noticed that the emphasis is laid rather on the leadership of thought than the training of youth. This is one of his main points; another is that a university should confine itself, both in the subjects studied and in the standard of study of them, to work of real university quality.

"The case, as I see it, must rest on the inherent and intellectual value of the proposed faculty or the proposed subject. Practical importance is not a sufficient title to academic recognition; if that is the best that can be said, it is an excellent reason for exclusion. . . . The pursuit of science and scholarship belongs to the university. What else belongs there? Assuredly neither secondary, technical, vocational, nor popular education. Of course, these are important; of course, society must create appropriate agencies to deal with them; but they must not be permitted to distract the university."

From this standpoint Dr. Flexner proceeds to criticise the universities of America, England and Germany.

His most detailed examination and his severest censures are reserved for his own country. While doing full justice to the enthusiasm for education, the versatility, the spirit of initiative and enterprise, characteristic of America, and the admirable work done by many individuals, he notices the low standard of secondary education, which leaves much to be done by the universities which should be done by the schools; and particularly he has hard things to say of the university curricula, with their craze for inclusion (in response to popular pressure) of subjects totally unworthy of a university—trivial, vocational, and material. His examples are chosen over the whole of the continent, and he does not spare even such famous institutions as Harvard, Yale and Princeton; but the vials of his wrath are poured especially upon Columbia and Chicago, and in a less degree upon Wisconsin. He condemns (and many of his countrymen join him in condemning) the inclusion of such subjects as "advertising layouts," "practical poultry raising," "food etiquette and hospitality," "principles of home laundering," "drug-store practice," "business letter-writing," and scores more of similar character. He condemns also the methods of propaganda practised by many universities, and the vulgarity of tone of their advertisements. Even the graduate colleges, which are rightly praised as the most meritorious part of the American university, are criticised for including work which does not come within the scope of a university. Another defect is over-mechanization, as shown in the methods of examination, the counting of "credits" for a degree, the craze for questionnaires, and elaborate working out of statistics to prove propositions which are obvious to natural commonsense. His general summary is that "the American university is becoming more and more tumultuous. They have increased their genuine facilities and opportunities; they have simultaneously and needlessly cheapened, vulgarized, and mechanized themselves." The ideal he would hold out, and to which he counsels them to return, is the admirable work done by Johns Hopkins University at Baltimore in its early days, when, with its limited numbers of selected graduates it was a leader of thought and research in subjects of real university quality.

Of English universities Dr. Flexner writes with a sympathy and courtesy which deserve the fullest recognition from his English readers. They will find much food for thought in his criticisms. We may note with pleasure his admission that "the ancient universities, whatever their defects—all, by the way, with characteristic English candour, acknowledged by some one or other—are as seats of higher learning incomparably superior to anything that has as yet been created in America." Secondary education also is on a higher level than in America, and is better articulated with the universities. He notes further a diversity of types, which is not found in America: the University of London (as to which he says, "if a university is, whatever its type or form, a highly vitalized organism . . . with a corporate life, I confess myself unable to understand in what sense the University of London is a university at all"), the provincial universities, and the ancient universities. The general defect is the emphasis laid, at school and university alike, on moral and social, rather than intellectual, training. "Persistent emphasis on what has been so strongly established as to be an obvious, essential, and characteristic national trait tends to distract attention from something else—the increased need of intelligence in the affairs of life—personal, political, social, and economic." For this criticism—for the tribute and still more for the emphasis on the defect—we can only be grateful, and we should do well to profit by it.

Of Oxford and Cambridge, Dr. Flexner writes in a tone of affection which we can only gratefully acknowledge. He cannot quite explain to himself how they happen to be great institutions of learning; he admits that he has not penetrated their secret; "yet there they are—institutions of learning, nevertheless, in the finest and highest sense of the term, national bulwarks against all that is frothy, shoddy and paltry in academic life." But he is not blind to their defects—the disproportion between the time devoted to teaching and the time available for research, the lack of facilities for advanced post-graduate work, inadequate pay for the non-professorial grades, the cumbrous machinery ("e pero si muove"), and certain developments in connexion with agriculture and forestry which might be better dealt with otherwise.

The German section is perhaps the least effective of the three, in spite of the fact that the German conception of the university comes nearest to Dr. Flexner's ideal. In Germany, at any rate since the founding of the University of Berlin at the beginning of the nineteenth century, learning has been held in proper honour, and the university has been recognized as an integral part of the State. Close association with the government has its dangers (as was seen in 1914), but it assures the status of learning, and on the whole (though with qualifications) it has not been incompatible with independence, nor hampered research. And the work of the professors has been of university standard—disinterested research for its own sake, not by any means neglecting teaching, but not submerging research in teaching.

All this is true of the German university of a generation ago. The question is how it will emerge from the present process of democratization, and how universities will fare under the present economic strain. The issue is still doubtful, and Dr. Flexner plainly is not in a position to estimate the present trend of development. He believes, however, that "the intellectual quality of the faculties and the permanent officials in the ministries is so high, the prestige of the universities so great, and their contribution to the nation's life so vital that, even if some problems can never be solved to the satisfaction of all, adjustments will be reached that will restore and perhaps even increase the efficiency of secondary and higher education."

Space does not allow more than this summary of a most stimulating and instructive book. There are many points of detail on which one is tempted to dwell, especially where one does not wholly accept Dr. Flexner's criticisms. The present reviewer is inclined, for instance, to demur to some of his observations on extra-mural teaching, on training in librarianship as a graduate study, and on the Bodleian; but even when one comes to a different conclusion, one benefits by criticism so intelligent, so well-informed, and so sympathetic as that of Dr. Flexner, and one can only conclude by recommending all who are concerned with university education to read and re-read his book.

Across the Gobi Desert. By SVEN HEDIN. Translated by H. J. CANT. (Routledge. 25*s.*).

The indefatigable Swedish traveller, Dr. Sven Hedin, started on his first Central Asian journey as long ago as 1885, when he was only twenty-one. Yet in his new book he is able to describe the arduous march which he made in 1927-28 with a party of Swedes, Germans and Chinese from Peking across the Gobi desert to Chinese Turkestan and the Siberian frontier. He suffered much from illness on the way, but he writes as vivaciously as ever. From the purely geographical standpoint the book contains little that is new, except the postscript recording recent work by one of his party on the mysterious lake, Lop-nor, in Eastern Turkestan (Sin-kiang), which has changed its location at intervals through the ages. Dr. Hedin states that his main purpose was to set up four permanent meteorological stations along the caravan route which he followed, and thus provide for the first time information about the weather, winds and rainfall in this region, which is 1,500 miles across. He evidently had much difficulty in obtaining permission to make the journey, now that Chinese Nationalism has taken offence at the efforts of foreign scientists like Sir Aurel Stein and Mr. Roy Chapman Andrews to continue the exploration of Southern Mongolia and Turkestan—a task that the Chinese themselves have never attempted. It is for this reason, no doubt, that the author stresses throughout the value of the work done by his Chinese colleagues, and makes but the barest mention of that of European and American explorers in the same field. Notwithstanding his agreement with the Peking authorities and the support of his own Government, which financed the expedition, Dr. Hedin had more than once to complain of official hindrances, and his observing stations in the desert were evidently regarded with suspicion. When he arrived in Sin-kiang after an eight months' journey, he found the governor, Marshal Yang, somewhat doubtful of his intentions, for the expedition had been magnified by Mongol rumour into an army of occupation. Yang, who had governed the Moslem province since before the fall of the monarchy in 1911, was soon convinced of Dr. Hedin's good faith and facilitated the work of his expedition. The author adds that, a few months later, Yang was assassinated by his right-hand man, who was executed for the crime. The narrative is largely concerned with the petty incidents of travel and the difficulties of supply which a large party in a barren country has always to face. Early in the tour the hundred and fifty camels bolted with their packs, and were reassembled with difficulty. Dr. Hedin's photographs are numerous and attractive, but it could be wished that he had described anew some of the ruined sites, especially Khara-Khoto, the deserted city near the Etsin-Gol, which is well known from Sir Aurel Stein's great book.

The Struggle for South America. By F. J. NORMANO. (Allen & Unwin. 12*s.* 6*d.*).

This book may well be reviewed in *Discovery*, as it describes a new aspect of commerce that has great significance for the future. A world economic state has often been suggested by Mr. H. G. Wells; but it has remained for a Brazilian to give a picture of "anational" business as it is already at work to-day. Dr. Normano has lived in Europe and the United States, and in discussing the trade of his native continent he brings a first-hand knowledge of American business to bear on its problems. The subject of his book will be fairly familiar to English readers by reason of the British Exhibition at Buenos Aires, but the sidelight it throws on American commercial policy is of much wider interest.

Before the war, British trade predominated in South America, where the railways and mines were developed by British engineers with enormous capital investments. The virtual withdrawal of our interests after 1914 gave the United States a chance she was not slow to take, and from a fourth place among the countries trading in this vast continent she rapidly secured the top position. As Dr. Normano explains, the chief progress was made in the most modern products of commerce, in which the Americans have specialized—motor-car accessories, wireless and motion pictures. "Even in these products there is no conquest of the continent involved. It is merely one of the manifestations of the world-wide expansion of particular branches of the United States mass-production system." Unlike the British concerns, in which the individual investor is involved, American enterprises abroad are mostly subsidiaries of corporations in the United States which own the entire capital. "It is no longer the spirit of Kipling's *Seven Seas*, nor of Shakespeare's royal merchant Antonio which motivates these concerns abroad. . . . Foreign enterprise is the automatic consequence of the press and stress of expanding mass-production. It is calculated, established and directed by business administration. And so it is that the fate of a mining enterprise in distant Bolivia may depend on the investigation carried out by a statistical department on the fifty-second floor of a skyscraper in New York."

It is suggested that this process in South America is merely an aspect of what is slowly happening the world over. The author sees the same process in other foreign markets, where the "American danger" is associated with the machine age, mass production and standardization, coupled with the intention of the United States to conquer the whole world economically. But American business is not concerned with particular nationalities, and it is admitted that "spiritual articles" are not produced in wholesale quantities, so that the North American *homo economicus* would hardly dedicate his energies to such

matters. The danger of such competition does not exist. "We must understand," says the author, "that the entire character of the United States expansion is indifferent to cultural victory. Neither the Western Union nor All America Cables is interested in the language used in cablegrams; nor is the I.T.T. anxious about the language of telephone conversations; nor the General Motors Company about the nationality of the passengers in their motor-cars." This new movement in world commerce is summed up by Dr. Normano as "no longer national nor even international but anational." The policy is without ulterior motives and is "business for business' sake like art for art's sake."

Witchcraft, Magic and Alchemy. By GILLOT DE GIVRY. Translated by J. COURTENAY LOCKE. (Harrap. 42*s*.).

It is impossible to do full justice to this remarkable work within the compass of an ordinary notice. The author has brought together a wonderful collection of pictures illustrating witchcraft and all forms of the occult, dating from the Middle Ages to the nineteenth century. There are no less than three hundred and sixty illustrations in the text and ten full-page plates in colour. The latter are excellent, as are most of the half-tone reproductions; but, as always, the finer textured woodcuts have suffered. This, however, is a matter of minor importance to the student, who is not so much concerned with the artistic merit of the pictures as with their significance as an index of the fantastic or terrifying lengths to which the human intellect was prepared to go in giving material form to religious and magical belief and to pseudo-scientific credulity. Here we have representations of the Last Judgment and Hell as pictured to the mediaeval eye, the temptations of saints and more ordinary mortals, the witch with her familiars, the sabbath in its various forms and stages, the entry into a pact with the devil, the evocation of demons and the raising of the dead, the various forms of the devil, the princes of darkness and the leaders of the legions of devils (who, it may be remembered, on a conservative estimate were numbered at 7,405,920), the astrologer, and methods of divination by the mirror, the hand and physiognomy, cards and dice and the divining rod, clairvoyance and finally the doctrines and methods of the alchemist. These last are of special interest, as here we see the early apparatus of the chemist. This catalogue of topics may serve as an indication of the scope of the collection; but it cannot even suggest its variety and interest. While some of the prints will be familiar to students of witchcraft, many of them are of extreme rarity. Some, again, are of high artistic merit, for masters such as Breughel, Teniers and Goya found in the occult a subject suited to the genius of their brush. The commentary which accompanies the illustrations is purely expository; but the author's wide acquaintance with the literature of the occult gives the book an added value as a work of reference. The claim that the book is unique is no exaggeration.

The Ingenious Dr. Franklin. Selected Scientific Letters. Edited by NATHAN G. GOODMAN. (Humphrey Milford. 15*s*.).

Daylight saving, the first aerial voyage by man, the art of procuring pleasant dreams and slaughtering by electricity are among the varied subjects discussed by Benjamin Franklin in his letters, some of which are here published for the first time. The letters are grouped under three headings: Practical Schemes and Suggestions, Divers Experiments and Observations, and Scientific Deductions and Conjectures. The book is delightful reading and the charm of this busy little man's rare personality is vividly conveyed. The letters are mostly addressed to personal friends, but the correspondents include Sir Joseph Banks, President of the Royal Society, Lord Kames, the Scottish judge, Joseph Priestly, and Sir John Pringle, the noted physician.

In a letter from France to Sir Joseph Banks in October, 1783, Franklin describes the first flight of the "hot air balloon," an ascent in which the promoters had not apparently sufficient faith to take part themselves. "I am told that the balloon was fill'd in about ten minutes by means of burning straw. Some say water was thrown into the flame, others that it was spirits of sal volatile. It was suppos'd to have risen about 200 toises, but it did not continue long at that height. So vast a bulk, when it began to rise so majestically in the air, struck the spectators with surprise and admiration. The basket contain'd a sheep, a duck & a cock, who except the cock, receiv'd no hurt by the fall."

The discovery of prehistoric remains near the river Ohio is described in a letter from London in January, 1768. "I sent you sometime since a tooth which was found near the river Ohio in America, at what is called the Great Licking Place, where the earth has a saltish taste that is agreeable to the buffaloes and deer who come there at certain seasons in great numbers to lick the same. At this place we have found the skeletons of nearly 30 large animals, 4 tusks and also one of the vertebrae. It appears to me that animals capable of carrying such very large and heavy tusks must themselves be large creatures, too heavy to have the activity necessary for pursuing and taking prey. And therefore I am inclin'd to think those knobs might be as useful to grind the small branches of trees as to chaw flesh."

The New Science and the Story of Evolution. By JOSEPH MCCABE. (Hutchinson. 7*s*. 6d.).

Mr. McCabe's new book, based on an earlier sketch of the evolution of the earth but largely rewritten in the light of recent research, is uncommonly readable and shows wide knowledge. At the same time it restates the materialist position and runs violently counter to the more or less idealistic theories to which Sir James Jeans and Sir Arthur Eddington have accorded perhaps more support than they intended to give. One may observe, without taking sides in this controversy, that Mr. McCabe is at least right in warning the layman not to rush to conclusions and assume that all physicists follow the lead of the two popular astronomers just named. Their hypotheses are of great interest, but it is far too soon to regard these hypotheses as laws of nature—as the final and unalterable truth. When Mr. McCabe passes from the universe in general to the earth in particular, and has restated his theory of creation—seemingly, to him, a matter of chance—he handles his main theme of evolution through the ages with abounding skill and vigour.

Geology and palaeontology are seldom made so attractive as here. It may be hinted, perhaps, that he is a little too sure of his inferences here and there, but in the main the long story is well summarized. And at the close he devotes several lively chapters to prehistoric man and to the beginnings of civilization, which depends, as he truly says, on contact between peoples and is retarded or killed by isolation. This would be a good text for advocates of the League of Nations. Mr. McCabe is free from the fashionable pessimism and ends on a note of unalloyed

hopefulness, looking forward to the "genial expansive period" that is to follow this age of transition. The book has a few interesting illustrations.

The Call and Claims of Natural Beauty. By G. M. TREVELYAN. (University of London. 1*s.*).

This is the text of the third Rickman Godlee lecture, recently delivered at University College. Professor Trevelyan points to two things as characteristic of our age, and more particularly of our island: the conscious appreciation of beauty, and the rapidity with which natural beauty is being destroyed. The appeal of natural beauty is made up of many different elements. Obviously one appeal is the aesthetic, yet even here we are in the region of disputes. A highly cultivated clergyman of the mid-eighteenth century, banished to a remote rectory in Northumberland, wrote to his friends in the south that in summer the moors around him were covered by the purple flower of a plant called ling which made the landscape "indescribably hideous."

Professor Trevelyan recalls the horror of mountains felt by civilized man until the latter part of the eighteenth century. Writing from the Highlands in 1725 a visitor expressed his acute distaste for their "stupendous bulk, frightful irregularity and horrid gloom, made yet more sombrous by the shades and faint reflections they communicate one to another." The author concludes with a plea for the preservation of natural beauty to-day. This is a civic duty which can no longer be neglected without dire consequences. Destruction walks by noonday. Unless the State reverses the engines, and instead of speeding up destruction, plans the development of the country so that the minimum of harm can be done to beauty, the future of our race, whatever its social, economic and political structure may be, will be brutish and shorn of spiritual value.

The Wonder Book of Science. By SIR ARTHUR SHIPLEY AND OTHERS. (Ward, Lock. 6*s.*).

This is a splendid addition to the series of Wonder Books. The story of modern discoveries in many fields of science is told in simple language. Sir Arthur Shipley writes on social animals, life's struggle and denizens of the deep; Dr. A. C. D. Crommelin takes readers for a trip to the planets; Dr. David Owen discusses molecules and atoms, electricity and magnetism; the story of the rocks is told by Dr. Herbert Thomas; and some easy experiments are suggested by Mr. Leonard Bastin. There are many delightful pictures in colour and tone. A coloured map of the moon, the result of many years of work, shows the craters, mountains and waterless depressions. There is a photograph of the huge sound detector used by the French Air Force to listen for the approach of aircraft; the apparatus is capable of registering the sound of engines twenty miles away and can give the exact altitude and position of the approaching planes. The book is a fund of information, charmingly told and well presented. It deserves as wide a sale as its predecessors in the series have enjoyed.

Colour Science. Part I. By WILHELM OSTWALD. Translated by J. SCOTT TAYLOR. (Windsor & Newton. 15*s.*).

In an introduction to this book the author suggests that the science of colour has not hitherto been "referred to its rightful habitat." The painters and dyers, the first to become familiar with colours in the course of their daily routine, did not find themselves in a position to develop their knowledge into a science. It was Newton's discovery that white light can be decomposed by a prism into a continuous band of varied colours that "enabled the physicist to pose as the originator and custodian of colour science." The painters and dyers then made the discovery that from three fundamental colours all intermediate hues could be produced, and in this way they developed a practical three-colour doctrine which was afterwards taken over by the physicists. In the manufacture of artificial colouring matters it was necessary that the resources of chemistry should be utilized, the result being that colour science has to some extent passed under the care of the chemists. Next, following Goethe's example, the physiological side of colour science was explored and cultivated until it developed into a physiological instruction. Finally, it became increasingly evident that, in the last analysis, colour is a sensation, and that its science must therefore be included in psychology. As a result of this uncertainty, the author states that it has only been possible for colour science to develop in a one-sided and imperfect manner. Quite recently, however, the measurement of colours and their constituents has at last been made practicable, and a systematically arranged science can now be built up.

Beauty in Animals.
China and the Chinese.
Negro Types. (Routledge. 2*s.* 6*d.* each).

These three fascinating books are the first of a new series containing about sixty camera studies with an introductory note and an explanation of the pictures. The books are quite the best of their kind that we have seen at the price, and deserve to be widely known. "Beauty in Animals" will perhaps have the widest appeal, the other books being rather more specialized in interest. The photograph of the flamingo, which is also reproduced on the wrapper, is a particularly clever example of modern camera work. In "China and the Chinese," Mr. von Perckhammer's photographs deal mainly with life in Peking and include some remarkable portraits of native types and Chinese architecture. In "Negro Types" the principal characteristics of the aboriginals are illustrated by means of selected types. The un-selfconscious nudity of the natives has enabled the photographer to present a series of natural studies which are, however, in no way offensive. The photograph on the wrapper might in this case have been improved upon, for the present example is by no means the best of the collection. Other inviting titles are in course of preparation, and the completion of the series will be awaited with interest.

A First Book of Nature Study. By EVELYN CHEESMAN. (Philip Allan. 3*s.* 6*d.*).

The aim of this attractive little book is "to make quite clear that the reason why we study the lower forms of life is to gain a knowledge of the laws which govern the human race and to realize as far as possible our own place in the universe." It is not a textbook, but is intended to provide a simple introduction to a course of nature study. The author has presented her subject in a most attractive way, and while the book is primarily intended for use in schools, it should have a far wider appeal. There are many illustrations in line, and at the end of the book are an outline for a course of lessons and a useful index.

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